

**VULNERABILITIES OF COASTAL TOURISM DESTINATIONS TO CLIMATE  
CHANGE RELATED INCIDENTS: - A CASE STUDY OF SELECTED HOLIDAY  
RESORTS ALONG THE WILD COAST, EASTERN CAPE, SOUTH AFRICA**

by

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## DECLARATION

I, Athina Ashle van der Byl, student number 209029935, solemnly declare that this dissertation entitled **"The vulnerabilities of coastal tourism destinations to climate change related incidents. A case study of selected holiday resorts along the WildCoast, Eastern Cape, South Africa."** is my own work and all sources used or quoted in the study have been indicated and acknowledged by way of complete references. This study has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

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## **DEDICATION**

I humbly dedicate my work to a number of people, I am thankful for the roles the following people played in my life.

Firstly, I would like to dedicate this work to my parents, Bernard and Suzette van der Byl, I value all the great characteristics they have instilled in me and for the support and love they have shown me through my years of studying.

Secondly, to my loving sisters, Sasha-lee and Bernelee for their patience, love and support. And to my family and friends, thank you for all the support and encouragements. May you also be motivated and encouraged to reach your dreams.

## **ABSTRACT**

Climate change is a global phenomenon with major impacts on coastlines, leaving coastal areas vulnerable to conditions such as sea level rise, flooding as well as storm surges, which results in increased damage to or loss of coastal property and infrastructure. The study examined the vulnerability of the Eastern Cape's Wild Coast resorts to climate change related impacts. Both qualitative and quantitative methods aided by questionnaires and GIS mapping were used to identify vulnerable settlements as well as their impacts. A meta analysis of the identified vulnerabilities was studied and strategies employed to reduce the impacts was also done. Results indicated that almost 80% of the Wild Coast resorts occur within the low-lying areas of the coast and these areas were mostly affected by impacts such as sea level rise, heavy rainfall and floods accompanied by storm surges. Another alarming challenge faced by the King Sabata Dalindyebo Municipality was controlling unplanned developments within these low-lying zones of the coast. Therefore, it is recommended that relevant departments provide awareness through various platforms such as workshops, programmes and campaigns to ensure that people understand the risk of climate change on low-lying areas as well as mainstreaming climate change in long term development planning. This study highlights a need for monitoring of coastal environments vulnerable to the impact of climate change along a South African coastline.

## **ACKNOWLEDGEMENTS**

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## TABLE OF CONTENTS

DECLARATION.....	ii
DECLARATION ON PLAGIARISM .....	iii
DEDICATION .....	iv
ABSTRACT.....	v
ACKNOWLEDGEMENTS.....	vi
LIST OF FIGURES .....	x
ABBREVIATIONS.....	xiii
CHAPTER 1 .....	1
1.1 INTRODUCTION.....	1
1.2 Definitions of terms .....	3
1.2.1 Sea Level Rise.....	3
1.2.2 Storm Surge .....	3
1.2.3 Prevention.....	3
1.2.4 Coastal Zone.....	3
1.2.5 Risk.....	3
1.2.6 Low Lying Zones.....	3
1.3 Problem Statement.....	3
1.4 Research Aim.....	4
1.5 Research Objectives .....	4
1.6 Research Questions.....	4
1.7 Rationale of the study .....	5
CHAPTER 2 .....	6
2.1 DESCRIPTION OF THE STUDY AREA.....	6
2.2. Population size of the study area.....	8
2.3 Age distribution in the study area .....	9
2.4 Educational levels in the study area .....	9
2.5 Climate of the study area .....	9
2.6 Type of vegetation of the study area .....	10
2.7 Geology and geomorphology of the study area.....	10

CHAPTER 3 .....	12
3.0 LITERATURE REVIEW .....	12
3.1 INTRODUCTION.....	12
3.2 Sea level rise.....	14
3.3 Storm surges .....	15
3.4 Floods .....	16
3.5 Coastal Erosion.....	17
3.6 Vulnerability of coastal settlements .....	18
3.7 Adaptation measures for coastal environments.....	20
3.8 Consequences of impacts on coastal property .....	21
CHAPTER 4 .....	23
4.1 INTRODUCTION.....	23
4.2 Primary sources of data.....	23
4.2.1 Direct Observations.....	23
4.2.2 Interviews.....	24
4.2.3 Questionnaires .....	24
4.3 Secondary sources of data .....	24
4.4 Data analysis .....	25
CHAPTER 5 .....	26
5.0 VULNERABLE COASTAL REGIONS OF COFFEE-BAY AND PORT ST JOHNS.....	26
5.1 INTRODUCTION.....	26
5.2 Presentation of results and data analysis.....	26
5.2.1 Materials and methods .....	26
5.2.2 Results.....	26
5.3 MAPPING VULNERABILITIES IN PORT ST JOHNS.....	27
5.4 MAPPING VULNERABILITY IN COFFEE-BAY .....	31
5.5 Discussion .....	32
Past and Present impacts.....	34
Sensitivity.....	34
Adaptive capacity.....	34
5.6 Conclusion.....	35
CHAPTER 6 .....	36
6.0 COASTAL RESORT OWNERS PERCEPTIONS TO CLIMATE CHANGE.....	36



6.1 INTRODUCTION.....	36
6.2 Presentation of results and data analysis.....	36
6.2.1 Results.....	36
6.3 Conclusion.....	50
6.4 Recommendations .....	50
CHAPTER 7 .....	51
7.0 LAWS GOVERNING COASTAL PROTECTION FROM GOVERNMENT OFFICIALS.....	51
7.1 INTRODUCTION.....	51
7.2 Materials and methods.....	51
7.3 Government Officials rating climate change for Wild Coast.....	51
7.3.1 Approaches used in ensuring coastal protection .....	52
7.3.2 The challenges faced in ensuring the implementation and protection of coastal areas.....	53
7.3.3. Policy principles identified for Wild Coast.....	54
7.4 Conclusion.....	56
CHAPTER 8 .....	58
8.0 OVERALL CONCLUSION AND RECOMMENDATIONS .....	58
8.1 INTRODUCTION.....	58
8.2 Recommendations .....	59
REFERENCES .....	61
APPENDIX A.....	70
APPENDIX B.....	77

## LIST OF FIGURES

<b>Figure No</b>	<b>Figure Caption</b>	<b>Page Number</b>
Figure 2.1	Map of the Eastern Cape showing the ORTDM	7
Figure 2.2	Map depicting municipal boundaries of study area	8
Figure 2.3	Gender distribution in the ORTDM	9
Figure3.1	Maximum surface temperature in South Africa by 2050	13
Figure 3.2	Changes in shoreline after coastal erosion	18
Figure 5.1	The coastline and river banks of Port St Johns showing 100m and 1km coastal zones	28
Figure 5.2	Resorts likely affected by a natural phenomenon at second beach, Port St Johns	29
Figure 5.3	Areas and Resorts affected by flooding in Port St Johns	30
Figure 5.4	The Coastline and river banks of Coffee Bay showing 100m and 1km coastal zone.	31
Figure 5.5	Resorts vulnerable to impacts of climate change in Coffee Bay.	32
Figure 5.6	Positions of affected resorts located along an estuary in Coffee Bay	33
Figure 5.7	Positions of affected resorts along Mthatha Mouth Coastline near Coffee Bay.	33

Figure 6.1	Understanding the risk of coastal living.	37
Figure 6.2	The year which the property was established.	38
Figure 6.3	Flooded Umvimvubo River and submerged resorts.	41
Figure 6.4	Flooded Port St Johns along the Umvimvubo River.	41
Figure 6.5	Preparedness against damage caused by climate change.	43
Figure 6.6	Reclaimed land after flooding in Port St Johns.	43
Figure 6.7	No vehicles allowed on banks of river.	44
Figure 6.8	Nursery as a method of soft engineering	44
Figure 6.9	Resort located along estuary in Port St Johns.	45
Figure 6.10	Wall built along an estuary in Coffee Bay.	46
Figure 6.11	Wall built along the Umvimvubo River, Port St Johns.	46
Figure 6.12	Concrete walls used as a preventive measure against floods.	47
Figure 6.13	Elevated Resorts in Port St Johns	49

<b>Table No</b>	<b>Table Caption</b>	<b>Page Number</b>
Table 6.1	Impact status to coastal resorts.	39-40

## **ABBREVIATIONS**

DEA	Department of Environmental Affairs
DEDEAT	Department of Economic Development Environmental Affairs and Tourism
GIS	Geographic Information Systems
IDP	Integrated Development Plan
IPPC	Intergovernmental Panel on Climate Change
ORTDM	O.R Tambo District Municipality
SPSS	Statistical Package for Social Sciences
UNEP	United Nations Environmental Programme

## CHAPTER 1

### 1.1 INTRODUCTION

Climate change is an internationally recognised phenomena and one of the greatest challenges of our time (The Department of Environmental Affairs, 2011). According to the United Nations Convention on Climate Change, climate change is generally attributed to human induced activities which changes the make- up of the overall atmosphere and includes the variations between climate and over a measurable time. Understanding climate change, one has to consider the fact that there is a natural aggregate of carbon dioxide found within our atmospheric level, and this amount together, with other greenhouse gases keeps the earth at an average temperature of 15°C (World Development Report, 2010). However, attributable to human actions, particularly fossil fuel burning, this natural balance exceeds its limits causing the earth to warm (The Department of Rural Development and Land Reform, 2013). This warming result in a global increase of temperature and resulting to increased occurrences of weather phenomena, rising sea levels and an elevation in precipitation levels. These changes threaten the well-being of communities across the world (The Department of Rural Development and Land Reform, 2013). Hegerl *et al* (2013), further mentions that climate change is characterised as a transformation in the condition of the climate conditions that can be defined as alterations in the total composition of the atmosphere for continued periods. Climate change is also characterised by other forces like alterations in the atmospheric radiation or even volcanism that has been occurring during industrial revolution, a consequence of negative human related actions (Hergel *et al.*, 2013).

Climate change is a relevant and critical issue for South Africa. According to Ziervogel et al. (2014), the annual temperature for South Africa elevated by almost 1.5 times with a monitored mean average of 0, 65°C in just over five decades

An increase in surface temperature results in an increase in sea level rise through processes such as thermal expansion of oceans and melting of ice glaciers. It is predicted that climate change may also bring intensified storms (Theron, 2008).

Recent observations show that the sea levels between 1993- 2006 was 3.3mm which is approximately 0, 4 mm/y (Rahmstorf *et al.*, 2007). The Intergovernmental Panel on Climate Change AR4 Report of (2007) highlighted that the average sea level rise would

continue to rise for the next coming years regardless if greenhouse gases were stabilised.

The Eastern Cape experiences a vast difference of climate conditions throughout different parts of provinces therefore climate conditions will affect South Africa in various ways (Allanson *et al.*, 1999). The O. R. Tambo region may most likely be affected by an increase in rainfall and unpredicted storms, violent in nature. This can then lead to impacts such as increased erosion, flooding and storm damage. The coastal zone of the Eastern Cape may be affected by sea level rise and storm surges with a resultant of coastal area damage, loss of infrastructure and changes to the coastline (Eastern Cape Socio-Economic Atlas, 2012).

Coastal environments are important for a variety of resources and uses. Coastal towns are used for habitation and recreation benefits to approximately 40% of South Africa's communities are located in coastal areas. Amongst recreational benefits, coastal areas provide amazing opportunities for holiday homes, work and settlements increasing coastal migration (The Department of Environmental Affairs, 2010). Climate Change may pose significant threat to not only water resources, food security, health but also to infrastructure (Ziervogel *et al.*, 2014). There is no doubt that South Africa's coastline experiences an immense amount of wave action. With climate change, there comes an increase storm actions, South Africa's coastline is susceptible to increased sea levels and other forceful and consequential weather events. Defences will be needed for low-lying areas to reduce the risk of impact or the threat of damage and loss of coastal property (The Department of Environmental Affairs, 2010).

The Department of Environmental Affairs, 2010 further mentions the loss of coastal infrastructure as a result of flooding and coastal erosion. Sea level rise may also cause inundation of low-lying coastal areas. According to the Department of Economic Development and Environmental Affairs (2012), the elevation of rainfall in the Eastern parts of the country is due to the increase in temperature. Generally the Wild Coast is likely to experience rises in sea level. It is therefore safe to suggest that the high rainfall, increase in flooding and storm events and sea level rise has to be strongly considered when identifying areas susceptible to vulnerability.

## **1.2 Definitions of terms**

### **1.2.1 Sea Level Rise**

According to Wright (2005), sea level rise is greatly the most threatening risk of climate change. It is researched that sea level rise is influenced by dual factors. This is through thermal expansion and the thawing of glaciers.

### **1.2.2 Storm Surge**

A storm is a violent weather condition that often includes extreme weather conditions, such as strong winds, thunder, lightning, heavy precipitation and hail (Park, 2001).

### **1.2.3 Prevention**

Prevention can be described as the activities taken that provide immense restraint of great risk of endangerment. It also relates to the minimisation of environmental disasters (UNEP, 2008).

### **1.2.4 Coastal Zone**

This is the area that consists of zones within the coastal environments, it is the area that includes the coastal public property followed by the zone after this, which is the buffer zone and the coastal access land which is designated for public use (Department of Environmental Affairs and Tourism, 2006).

### **1.2.5 Risk**

Risk is associated with the chances of loss and endangerment. These include environmental disruptions, loss of lives, economical disturbances. It includes a correspondence between the natural disturbances or human induced activities (UNEP, 2008).

### **1.2.6 Low Lying Zones**

Low lying zones are areas that are located near sea level or areas which are situated below the normal average altitude level (Gutie'rrez *et al.*, 2016).

## **1.3 Problem Statement**

Coastal regions around the world are experiencing a rapid rate of population growth and followed by the need for development (UNEP/Nairobi Convention Secretariat, 2009). Although coastal areas are desirable both for settlement and natural resources, they are environments in which several conditions hazardous to humans may occur, such as flooding and erosion.



Coastal areas are particularly vulnerable to climate change, as climate change brings about conditions such as sea level rise, floods, tsunamis, coastal erosion and storm surges which result in the loss of coastal structures, this greatly impacts low lying areas, coastal plains with resultant impact on coastal settlements (Langis, 2013).

The Wild Coast is particularly experiencing widespread unplanned, uncontrolled, and illegal development of settlements in low lying zones of the coast, thus resulting in the risk of these settlements being impacted by such conditions with an end result of loss of infrastructure and property. The impacts of sea level rise combined with violent storm surges is a particular risk for infrastructure and settlements. Climate change manifestations may result in a number of impacts such as increased damage or loss of coastal properties and infrastructure and the direct loss of livelihoods within prone coastal areas (Leone *et al.*, 1996).

Seaside locations are more likely to be impacted by detrimental impacts of climate change. There are many coastal resorts – residential developments along the coastline of the Eastern Cape particularly the Wild Coast, therefore local efforts for coastal protection becomes a very dynamic and complex criteria as these resorts provide services of tourism and boosting the economic revenue of these local developing coastal towns. Another issue is that not much consideration is placed on disaster management and environmental education. The public should always be made aware of the vulnerabilities that exists that could possibly affect them.

#### **1.4 Research Aim**

The aim of this study was to investigate the impacts of climate change on selected coastal leisure destinations on the Wild Coast in the Eastern Cape, South Africa.

#### **1.5 Research Objectives**

- To identify and map areas of vulnerability to the impact of climate change along the Wild Coast;
- To explore communities perceptions on climate change and its impacts on settlements; and
- To examine the existing strategies to ensure the protection of coastal settlements.

#### **1.6 Research Questions**

- Are there any areas of vulnerability along the Wild Coast?

- What are the perceptions of the communities on the impacts of climate change and coastal settlements?
- Are there existing strategies to ensure the protection of coastal areas?

### **1.7 Rationale of the study**

Recommendations made from this study can be taken from this research and could be made available as a guide in the protection of coastal areas.

- It will serve as a guide to facilitate the engagements between communities and how they prepare to deal with the impacts of environmental disasters.
- To prioritise strategies of disaster risk management to include ideas of coastal development planning.
- The study may also be used as a guide to support local adaptation measures.
- The study will also identify the areas that need coastal protection strategies as well as create awareness on the types of locations suitable for development.
- The study will reveal strategies that need to be put in place to ensure the protection of coastal communities.

### **1.8 Research Assumptions**

Without proper protection strategies put in place such as vulnerability mapping as well as engineering approaches to reduce the impact of climate change on coastal communities, impacts on these communities will become an issue of concern. Impacts such as sea level rise, storm surges and flooding will in the end damage much of coastal property

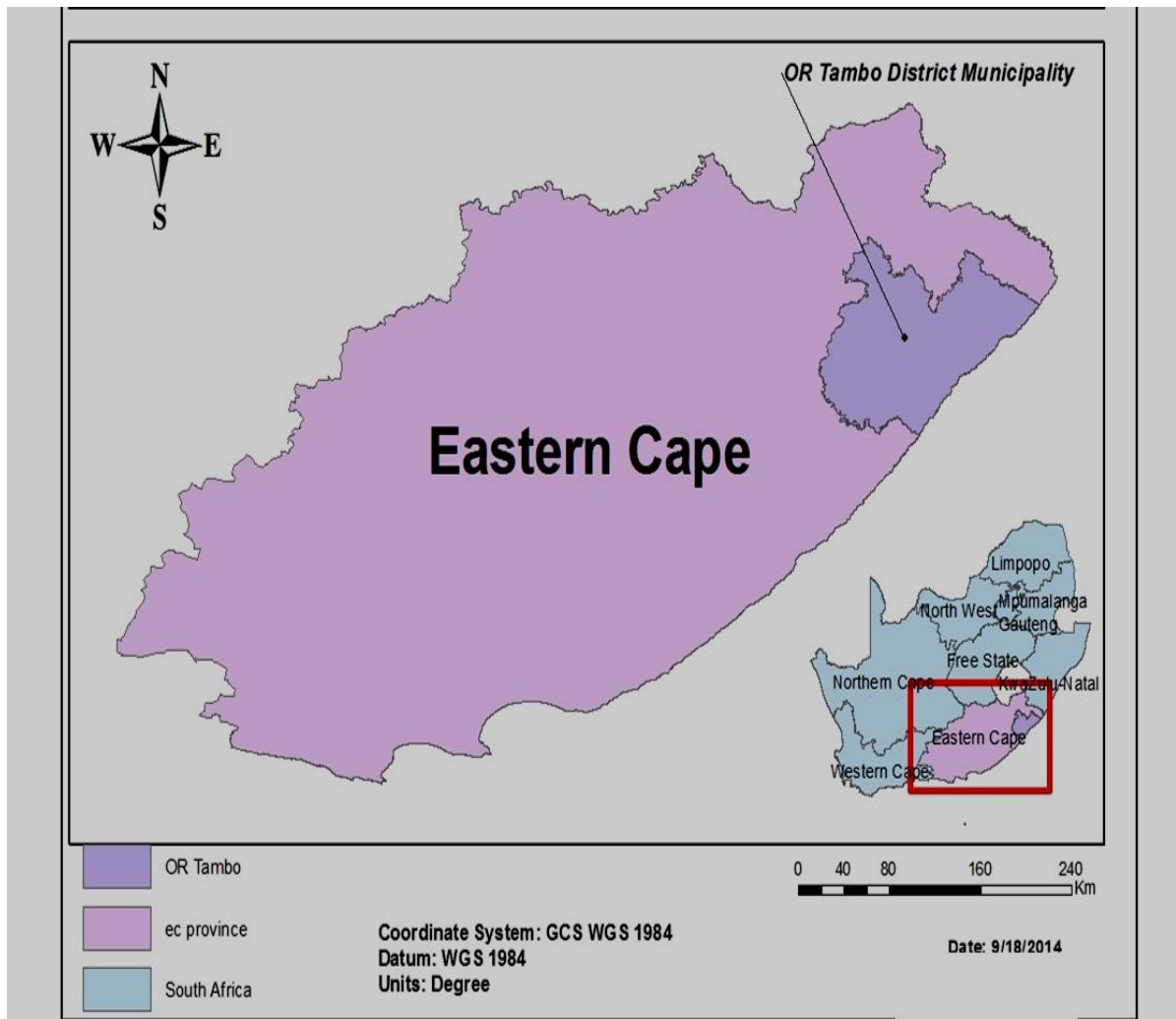
## CHAPTER 2

### 2.1 DESCRIPTION OF THE STUDY AREA

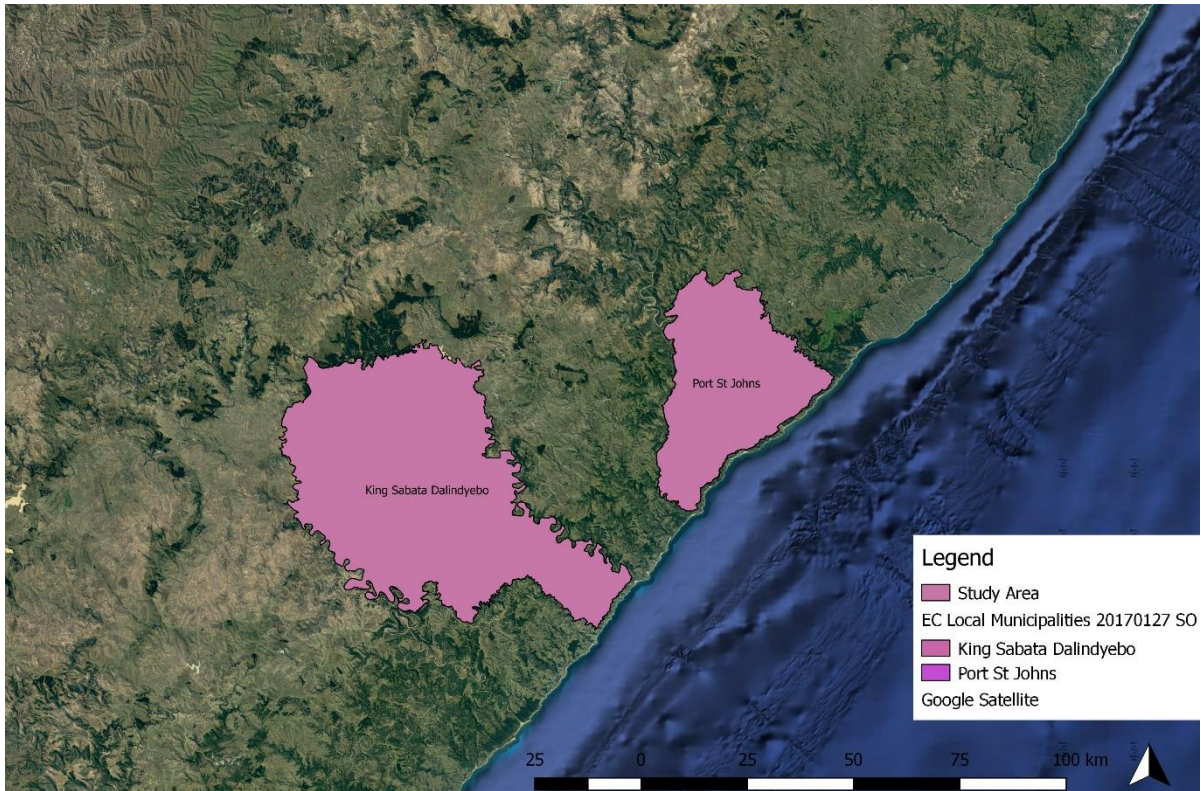
The Wild Coast coastline begins roughly at the Great Kei River and ends at the Umtamvuna River and covers a distance of approximately 320km. It is known for its majestic coastal beauty and regarded as one of the regions that hosts important plant and animal species (De Villiers *et al.*, 2016). The Wild Coast is the habitat of the Pondoland coastline and recognised as the centre of valued indigenous vegetation which occur only in these parts of the world (De Villiers *et al.*, 2016). The Wild Coast population is growing in numbers due to the migration of people to the coastline (Department of Economic Development and Environmental Affairs, 2013).

The OR Tambo District Municipality covers the coastal regions of the Eastern Cape and is bordered by Kwazulu-Natal and other districts of the Eastern Cape. These include the Alfred Nzo, the Amatole, Chris Hani and the Ukhahlamba Municipality (Annexure 5: District Profile: OR Tambo District Municipality DC15).

Port St Johns (31.6288°S, 29.5369°E) is situated along the Wild Coast falls within the Port St Johns Local Municipality and is widely renowned for its immense beauty and sub-tropical climate. Coffee Bay (31.9849°S, 29.1492°E) also situated along the Wild Coast falls within the King Sabata Dalindyebo Local Municipality. Coffee Bay is known to be a tourism node for the local municipality. It is known for the lush coastal forests, mangroves as well as pristine beaches (IDP 2014/2015).



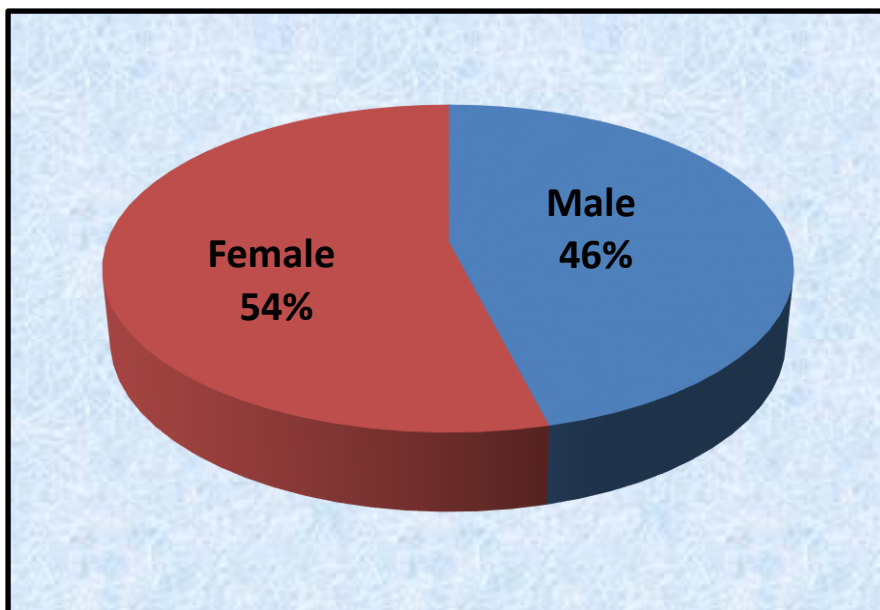
**Figure 2.1:** Map of the Eastern Cape showing the OR Tambo District Municipality.



**Figure 2.2:** Map depicting the municipal boundaries of the study area

## 2.2. Population size of the study area

South African Statistics (2013), recorded that the O. R. Tambo District Municipality accounted for an estimated 1961815 people in the region, with the racial composition:- black people accounts for 99.4 % of people in the district, 0.4% for coloured people, 0.1 % of the population being Asian and the lowest of 0.009% account for white people. The population comprises of a total of 54.20% females and males estimated at 45.80%. The annual population growth for the O. R. Tambo District Municipality is measured at 1% since the year 2005(Eastern Cape Socio Economic Consultative Council, 2014).



**Figure 2.3:** Gender distributions in the O.R. Tambo District Municipality.

**Source:** Eastern Cape Socio Economic Consultative Council, 2014).

### **2.3 Age distribution in the study area**

The O. R. Tambo District Municipality has a high number of youth population. The number of people aged between 5-19 years old account for 39.13% of the population. People aged between 20-64 years account for 41.02% and people with the age of 65 and above is 5.33% of the districts distribution (Annexure 5:District Profile: OR Tambo District Municipality DC15).

### **2.4 Educational levels in the study area**

The O. R. Tambo District Municipality shows a very low level of education for the jurisdiction with an illiteracy rate of 20.8%, which is considered to be a huge gap in comparison to people with post graduate qualifications (IDP, 2015-2016). Many people within the district do not even complete high school and the levels of unemployment stand at an alarming rate of 70.76%. Educational levels for the region are at 9.92% of people who have grade 12 certificates and 3.85% of people with post graduate qualifications (Annexure 5:District Profile: OR Tambo District Municipality DC15).

### **2.5 Climate of the study area**

The O.R. Tambo District Municipality is located within a subtropical region of the Eastern Cape Province with most of the areas occurring in high elevations where temperatures range from a mean minimum of 14.3-19.8 °C in January and 1.8- 13.4

°C in July to a mean maximum of 14.3-25.3 °C in January and 19.5-21.4 °C in July. The region receives most of its rainfall in the summer season with annual rainfall of above 80mm. The coastal areas located in the district receive an appreciable amount of rainfall in the winter seasons (IDP, 2015-2016).

## **2.6 Type of vegetation of the study area**

The study area can be characterised by a wide variety of different types of habitats including grasslands, coastal forests, valley thicket, thorny bushveld, coastal and marine habitats. Two components are of particular interest. The coastal forests, bushveld and grassland of the Bomvu area has been identified as a "centre of "Aloe" plant (De Villiers *et al.*, 2006). This terrestrial biodiversity is matched by extremely rich marine biodiversity, also with a large number of endemic fish species. The Wild Coast has been identified as one of WWF International's Global 200 Eco-regions of Global Significance (IDP, 2014-2015).

## **2.7 Geology and geomorphology of the study area**

The geology of the Eastern Cape is generally dominated and covered by sedimentary rocks, predominantly clay and sandy based soils (Eastern Cape Socio Economic Consultative Council, 2012). The O.R. Tambo District is underlain by a variety of lithologies (rock types) representing a considerable time span. As a broad generalization, the area is underlain by sedimentary rocks (sandstones and shales), through which magmas have intruded to form dolerite dykes and sills (IDP, 2014-2015). The dolerite dykes represent the conduits that fed the lavas that form the higher lying areas of the Drakensberg. Kimberlites, diatremes and other centres of volcanic activity also occur at a number of localities within O.R. Tambo District.

The underlying geology and geomorphology of the region are closely tied to the formation of soils. In general, soils are arable with much of the more productive soils currently under cultivation (IDP, 2014-2015). The soils of the Eastern Cape are typically recognised as shallow and unstable and less developed with only a few regions that receive rainfall. Soil erosion is also a major concern in the region as the region predominately covered by sandy soils and some dry conditions. (Eastern Cape Socio Economic Consultative Council, 2012).

## **2.8 Limitations of the study**

Conducting research is a very complex investigation and therefore limitations will exist, although this is not intended as likely to occur. There are a number of factors that hinder a study. One of those limitations may be that a researcher may not be from the area of study and therefore might result in other social implications, people tend to be very aware and guarded to people investigating certain conditions. Another issue experienced while conducting thorough investigations is the issue of language barriers, the research falls in regions where isiXhosa is a dominant language and not for the researcher. Therefore much preparation and thought had to be placed in the writing and asking of questions. Another issue associated with this research was that management of most resorts is placed under new management every two years hindering the ability to receive valuable historical information.

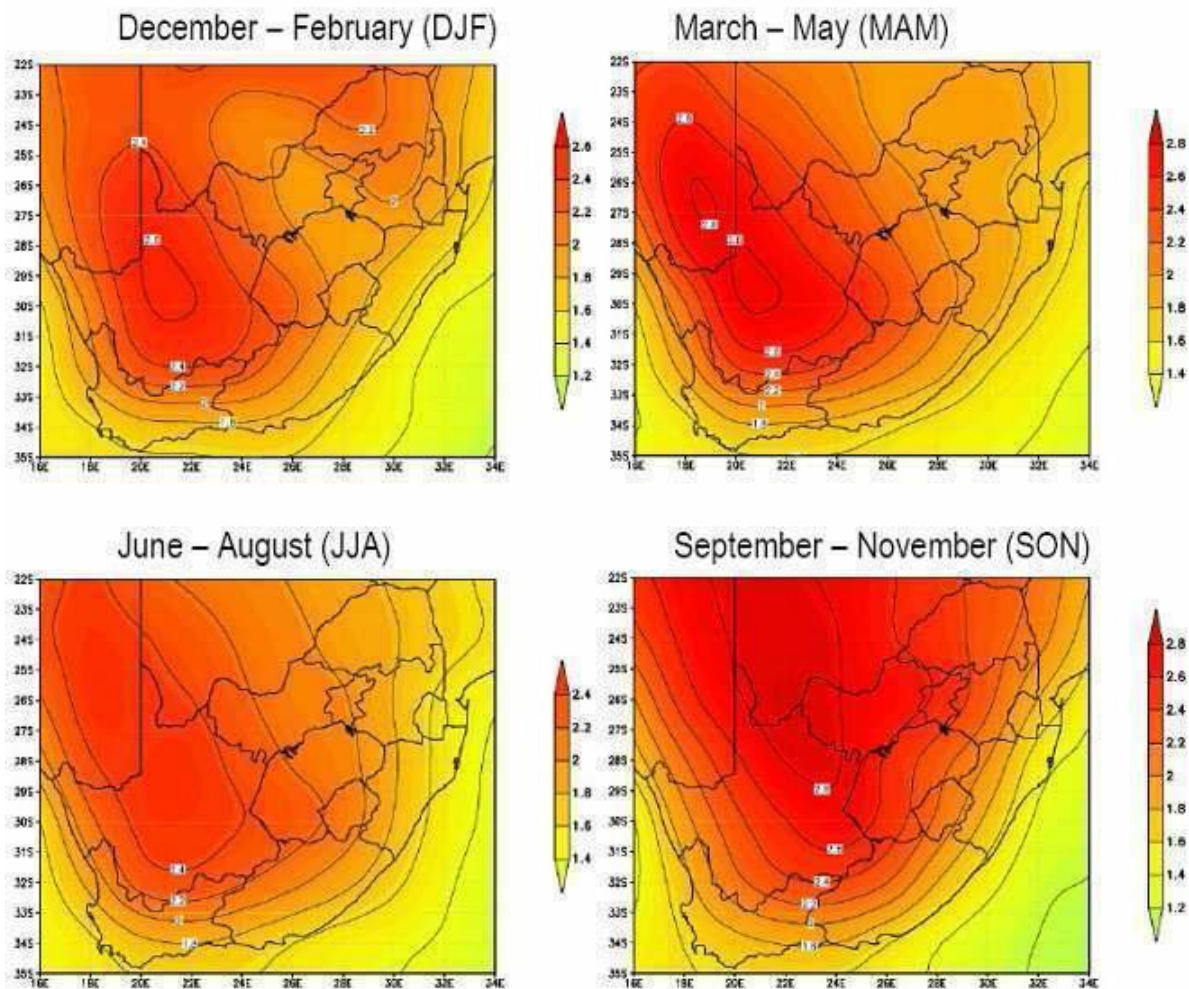


## **CHAPTER 3**

### **3.0 LITERATURE REVIEW**

#### **3.1 INTRODUCTION**

According to Hulme *et al* (1997), the climate of our earth has never been stable during the past decades or even through the evolution of human species. Globally, glacial periods have been 4-5°C cooler and some interglacial records have shown warmer temperatures of 1-2 °C. These changes have been of natural origins, although the causes are now much dominated by human perturbation of the atmosphere. The rate of warming already exceeds rates experienced over the last 10 000 years and is likely to be more intense (World Development Report, 2010). Stenseth *et al* (2002) states that the warming of the climate or whatever magnitude will inevitably result in the alteration of weather characteristics experienced in all regions and localities. This alteration could for example, alter the distribution of precipitation over the earth's surface, the frequency and severity of storms, and the nature of thermal regimes such as the extremes of heat and extreme cold.



**Figure 3.1:** Maximum surface temperature in South Africa by 2050.

**Source:** Midgley *et al.*, 2007 cited in the Draft for the Eastern Cape Climate Change Strategy).

The earth warming associated with climate change, will rise sea levels throughout the centuries to come and will significantly increase in intensity and frequency in the next centuries (Nunn, 2000). According to Warrick and Jager (1986), oceans contain almost 97.3% of the water mass on the Earth and provides as a major reservoir or the primary source of water through the atmosphere and its continents. Almost 86% of the world's evaporation comes from the ocean and approximately 78% of the global precipitation falls back into the ocean (Hartman, 2016). Therefore, it is important to consider the effects of climate change on the sea, to include results such as sea level rise and the level of thermal expansion of the ocean.

### 3.2 Sea level rise

Over the past 20 000 years, sea levels around the world has risen relative to the land at widely different rates, and that continues in most regions today (Peck et al, 2003). The geological record shows evidence which indicates that sea levels has changed drastically in the past of approximately 3.5mm/year (Douglas et al, 2000). Reasons for these rises includes climatic conditions, which may have resulted in the melting of ice sheets (Emery *et al.*, 1991).

There are a number of contributing factors to the global sea level rise. Gornitz, (1989) mentions four major sources to sea level rise trends, these are: thermal expansion of oceans, alpine glacier melt, the melting of the Greenland ice sheet, the melting of the Western Antarctic ice sheet.

Thermal Expansion is the resultant of increased temperatures on oceans, as the water temperature rises, molecules then occupy larger water volumes (Nicholls and Lowe, 2007). The second attribute to sea level rise is the melting of mountainous ice sheets. It is recorded that in the 20<sup>th</sup> century most mountain glaciers melted, this increased the water volume in oceans globally (World Glacier Monitoring Service, 2007).

According to Cabanes *et al.*, (2001) there is very little doubt that recent sea level rise has been driven largely by rise in temperature. The increase in surface temperatures results in the melting of land- based ice, which inevitably ends up in our oceans and results in the rising of the sea levels.

Cabanes *et al.*, (2001) further mentions a number of these reasons for the rise in sea levels, these includes the movement of the earth's crust which is caused by tectonic plate movement. Another change in sea level is one caused by isostatic adjustment; this occurs when the earth's crust sinks under bulk piles of heavy loads of ice, and therefore rises when the piles are removed (Douglas *et al.*, 2000).

Sea level rise during the 21<sup>st</sup> century had been reported to have major detrimental negative impacts on the world's coastline and the 21% that live along these coastlines (Gommes *et al.*, 1997). Increased storm surges hazards associated with sea level rise may leave many affected. It has been estimated that currently almost 46 million people per year are affected by flooding associated with occurred storm surges and about 118 million people or more if population grows will be affected by sea level rise (Watson *et al.*, 2001).

The distribution of future sea-level rise is not going to be uniform over the surface of the oceans (Bindoff *et al.*, 2007). It is therefore important that each region identifies the extent of sea-level rise, which is likely to occur locally. Recent analysis of the Southern African rates of sea level rise show that sea-level rose at a rate of 2.7 mm per year (95% confidence level  $\pm 0.05\text{mm}$ ) (1972-2003) in Durban (Mather *et al.*, 2009). The recent rate of sea-level rise shows a more regional difference across the South African coastline, with the west coast rising 1.87 mm per year, the south coast by 1.47 mm per year and the east coast by about 2.74mm per year (Mather *et al.*, 2009). These differences are due to the impact of the Benguela and Agulhas ocean currents both experienced by the South African coastline and tectonic movements. The rate of sea level rise is likely to increase in the near future, but there is currently still a high degree of uncertainty over the time scales and extent of change (Department of Environmental Affairs, 2011).

### **3.3 Storm surges**

The increase in global climate temperatures is evident at all latitudes and in all oceans. The scientific evidence indicates that the increase in climatic temperatures will intensify and thus intensify in cyclonic pressures and increase the frequency of storm surges and ultimately creating flood activities that may be detrimental for low-lying coastal areas (Dusgupta, 2009).

Storms are a great hazard to coastal communities, but a number of different hazards are more often accompanied with storms. A coastline that experiences a higher storm frequency is more damaging than another with fewer storms (Pawlukiewicz *et al.*, 2007). Storm intensity is another factor that contributes to the level of damage caused by the storm, wind speed is normally the determining factor for intensity and frequency of a storm (Zscau *et al.*, 2003). Storm surges that cause flooding are highly dependent on the geological attributed of the coastline. Lastly, erosive forces created during these storms can destroy homes, businesses, roads, and other infrastructure (Pawlukiewicz *et al.*, 2007).

South Africa has noted a number of storm surge phenomena's. In the year 2007, South Africa's coastline experienced the most detrimental impacts of storm surges (Mather, 2009). The storm surge event was initiated by a low pressure system, this also occurred when the tide levels almost reached the 18.6 year peak of the Lunar

Nodal Cycle. This combination resulted in intensified and high waves with raised sea levels which caused great damage along the entire Kwazulu Natal coast (Mather, 2006).

The storm started as a frontal low which passed south along the coast of South Africa. This frontal low intensified rapidly and cut off low south east of East London. Another case is that of an extreme event which occurred in 2008 along the Cape coastline (Theron, 2010). Waters reaching levels at a wave height of 10.7m (Theron, 2010). A frontal weather system developed at approximately 600kilometres south west of Cape Town and a secondary low pressure then developed and this resulted into an explosive cyclogenesis (Hunter, 2008).

South Africa's communities are becoming more susceptible and vulnerable due to intensified developments along the coastline. The threat of such events in the future has been accepted as an increase in frequency of more extreme cyclones and storms is predicted for the coming years because of the mid latitude westerly winds strengthening since the 1960's (Theron, 2007). Hewitson (2006) reported that South Africa is likely to experience an increase in wind speed, this speed on coastal environments will increase coastal processes, thus increasing wave heights and longshore transport. These impacts are likely to affect areas with weakened shorelines and areas of vulnerability (eThekweni Municipality, 2009).

### **3.4 Floods**

According to the National Disaster Management Centre (2013), floods are normally referred to as water run off or the rise in water levels in a particular area which is more than an environment can absorb. Floods can be caused by a number of weather occurrences such as rain or even storm surges, which are driven by strong winds. Floods can also generate in coastal areas, these are known as coastal floods. These coastal floods are caused by severe coastal storms which are normally associated with large waves that flood coastal areas with sea water (Wright, 1990).

Coastal floods affect huge oceanic life. The initial stages of a coastal storm can usually occur between a few hours to days while the actual flooding or sea rise would occur between four to eight hours (Wright, 1990). Coastal flooding accompanied by large waves and other debris transported by the wave action may result in beach erosion and extensive damage to infrastructure along the coast. Coastal areas are also

affected by riverine floods which are normally caused by long periods of rain in a catchment area (Halloway *et al.*, 2008).

### **3.5 Coastal Erosion**

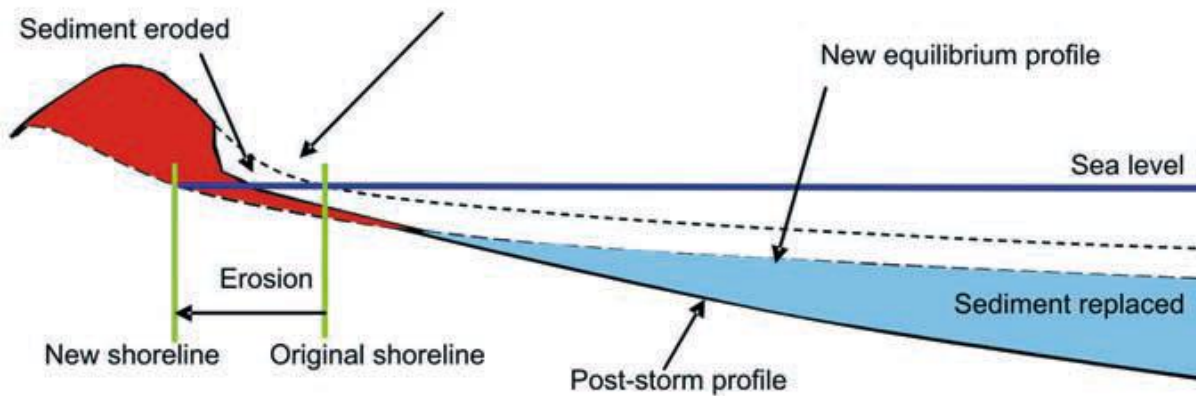
Most of Africa's coastline or coastal zone is vulnerable to physical coastal change such as coastal erosion (Watson *et al.*, 1999). Coastal erosion is much likely caused by sea level rise and progressive flooding of low lands and said likely to increase sea (IPPC, 2011).

Breetzke (2008) mentions that coastal erosion is the weathering action of rocks and the deposition of beaches or sand dunes through intensified wave action, tidal actions and runoff. Coastal erosion results in three different impacts, these are:

The direct loss and damage to the built environment found along coastal areas, the destruction of natural defences such as sand dunes, and the destruction and damage of artificial sea defences.

The rate of erosion along coastlines is known to vary, and is immensely affected by geomorphology (Watson *et al.*, 1999). Coastal erosion is defined as the loss of sand which is normally the resultant of a number of attributes; such as development and mining but greatly the result of sea level rise and storm surges (Smith *et al.*, 2007).

The reason for much disruption caused by coastal erosion is that many people have built homes and settlements close to the sea and upon doing this, much of the natural vegetation had to be removed during construction of these homes. This then results in the loss of coastal natural drainage system and increased run off. Such activities are increased by intensified storms and heavy rainfall thus resulting in loss of property (Hill, 2000). The Kwazulu- Natal for example is a particularly vulnerable coastline to erosion due to its exposure to cyclonic activities and wave events (Mather, 2006). A number of cases have impacted the coastline. The most noticeable occurrence was due to a wave event in 1996 as well as a large wave event off the coastline of East London in 1997 (Guastella *et al.*, 2009). The most recent erosional activity occurred in 2007, which was driven by large cyclonic wave events (Smith *et al.*, 2007). Coastal areas are sometimes perceived as a stable environment yet coastal areas undergo slow coastal events such as induced erosion storms which threaten coastal environments (Breetzke, 2008).



**Figure 3.2:** Changes to a shoreline after coastal erosion

**Source:** Mather, 2007

### 3.6 Vulnerability of coastal settlements

There is uncertainty over the extent and the rate of climate change and induced sea levels that are continuously rising. While most of people cite the potential for new coastal properties and development, the reality is that almost over 60% of the world's population live in coastal areas (Cartwright, 2012). Human population have always favoured settlement developments along coastal regions, despite environmental problems and the increasing impacts on coastal areas as well as the ability of coasts to sustain human use and development pressures on the coast (EuroSION, 2004). Coastal communities are more vulnerable to climate change than inland environments because in addition to meteorological changes, oceans are also affected by changes in oceanic factors especially increases in sea levels and wave heights (Michel et al, 2010). Also through other impacts such as coastal erosion, storm surges and water temperature (Tsimplis, 2004).

The impact of a changing climate will differ significantly across geographical areas. Systems such as oceans are especially vulnerable to climate change because of the limited adaptive capacity. Some of these systems may undergo significant and irreversible damage. The vulnerability of human systems in the coastal zone varies with geographical location, time, social and environmental conditions (IPPC, 2011). Climate change has the ability to affect the social, economic and the environmental well-being of communities. Therefore it is important that local authorities have a key

role to play in ensuring that buildings and infrastructure are protected in the changing climate (UKCIP, 2003).

The IPCC (2008 edition) reported that climate change will catalyse changes within oceanic systems, such as sea level rise, changes in temperatures and changes in precipitation. All these changes bring conditions such as droughts, floods and even storms. While there is much uncertainty to the projections and the extent of climate change, its consequences will change the fate of many generations to come particularly poor people.

Although Cartwright (2012) mentions that vulnerability to the physical impact of sea level rise in South Africa is not loaded on the poor, South Africa's legacy of apartheid places much of affluent people and local authorities at much of the countries coastal properties. These exclusions of much of South Africa's population from the coastal areas until the 1990's now complicates the coastal zoning which much of it boils down to politically sensitive issues. Settlements in coastal lowlands are especially vulnerable to risks resulting from climate change yet these are growing uncontrollably, to the extent that settlements are found within low lying zones of the coast (McGranahan *et al.*, 2007). Coastal populations are at risk of sea level rise, stronger storms and other hazards caused by climate change. McGranahan *et al.*(2007) reported that populations have always preferred living near the coastline and within the specified 100 kilometres of the coast line and also near rivers at the coast thus increasing the vulnerability. Climate change and sea level rise will affect coastal settlements and infrastructure in a number of ways. Sea level rise raises extreme water levels and possible increase in storm intensity and other additional climatic conditions which will impact coastal areas. Also degradation of the oceans natural ability to defend its environment is decreasing leaving the coastal environment susceptible to extreme sea level rise and extreme water levels. The growing population and the increase in resort development create a greater vulnerability (Nicholls *et al.*, 2007).

The Heinz Center (2000) mentioned that families roles in settlements are highly affected after a disastrous coastal storm and suffer severe changes that are associated with households, employment disruptions, economic hardship, poor living conditions and the disruptions of public services. Indirect threats due to climate change conditions may accelerate health problems which normally results from damaged



homes and utilities, extreme temperatures, debris and mud borne bacteria, mildew and mould. Climatic events are very detrimental on coastal families and owners of coastal properties.

The Long Term Adaptation Flagship Research Programme (2013) outlines a number of consequences of sea level rise and storm surges. These include: A decreased availability of freshwater in systems due to saltwater intrusions, increased risks of deaths and injuries by drowning in floods and migration related health effects, loss of property and livelihoods, loss of property and withdrawal of risk coverage in vulnerable areas by private insurers and, permanent erosion and submersion of land and potential losses in capital assets such as land, property and infrastructure can be based on accelerated depreciation costs of capital assets particularly that of land.

### **3.7 Adaptation measures for coastal environments**

In order to understand the risk of climate change on coastal area, one has to understand the adaptation of an area as well as the areas vulnerability. Adaptation can then be defined as the action used to minimise the adverse impacts of climate change and also used to take advantage of opportunities it might present (Watson, 1999). This is important if we want to minimise the impacts of climate change. Without the adaptation put in place, a rising sea level would negatively impact coastal areas, although the impacts would also depend on the coastal types and its relative topography (UKCIP, 2003).

According to the Canadian Climate Impacts and Adaptation Research Network (CCIARN, 2006), adaptation can be proactive (changes are brought before there are impacts) or reactive (measures are implemented after there are impacts). Adaptation measures are more often implemented after a natural disaster. They can be spontaneous or planned. In most cases, proactive and planned adaptation measures are less costly in the long term and more efficient than reactive adaptation. Climate change adaptation on the coast must be acknowledged and understood as an important challenge for managing coastal resource uses and must be prioritised in coastal policy establishments and plans at all levels. Prioritising means that climate concerns and adaptation responses should be integrated into relevant development policies, plans, programs, and projects at the national, sub-national, and local scales.

National climate change adaptation strategies are more effective when guidance on adaptation is mainstreamed into development and sectoral plans and strategies and is owned by those authorities responsible for preparing and implementing them.

Adaptation measures have been grouped in eight categories by the Stockholm Environment Institute (2008). These are:

Supporting losses: when a community cannot respond or rather the adaptive measures are too expensive,

Sharing losses: share losses between different systems or populations,

Changing the threat: creating and adopting measures to reduce the impacts of climate change,

Preventing the effects: consider climate change when planning,

Changing the use: change, for example, the use of the land facing climatic risks.

Changing location: developing in areas where the risk and vulnerability is minimised,

Carrying out research: gain knowledge or develop technological innovations to support adaptation to climatic risks and educating, informing, and encouraging changes in behaviours: sharing knowledge through various platforms and such as workshops and campaigns (Stockholm Environment Institute, 2008).

### **3.8 Consequences of impacts on coastal property**

There is a number of indirect consequences of climate change to coastal resorts. Coastal resort businesses are increasingly challenged by environmental disasters which are brought by a rapid action of natural events such as floods, windstorms, surge storms and hurricanes. Climate can be recognised as a factor that ultimately controls factors such as tourism (United Nations Environment Programme, 2008). It determines the climate conditions and suitable location for tourists. Changes in the environment bring about conditions such as coastal erosion, increased natural hazards, damaged property and infrastructure impact tourism development on varying degrees (United Nations Environment Programme, 2008).

The IPCC (2008) recognised that coastal town tourism revenues would also be affected by climate change impacts through increased expenditures on damaged property, additional emergency preparedness. Ensuring certain requirements are put in place such as building barriers, back up water and power systems as well as evacuations and business interruptions.

It is therefore important to recognise the vulnerability of coastal settlement to the ever changing impacts of climate change and to assess the adaptive capacity of these settlements. Local authorities therefore need to integrate climate change into sustainable development policies, land use planning and reinforce positive initiative to manage the natural environment (Yorkshire, 2002).

## **CHAPTER 4**

### **RESEARCH METHODOLOGY**

#### **4.1 INTRODUCTION**

This chapter deals with the research design and the different methods that were employed during the research gatherings and data collection. This chapter briefly focuses on the methods used to collect data and the procedures followed to analyse the data. Both qualitative and quantitative methods were used as sources of data. Merriam (2009) mentions that qualitative research normally attempts to study people's perceptions and understandings of how things came about in the social world. It analyses how people perceive certain experiences, what their views are or how they explore the unknown. The quantitative method of research as opined by Hancock et al (2009) is a research tool that uses statistical techniques that allow investigations on how likely something is true for a given population and is measured as an objective, quantitative methods also involves the manipulation of some variables.

#### **4.2 Primary sources of data**

Primary data collection allows the researcher to have full control of the research and allows for the manipulation of one or more variables. Primary data collection techniques used is direct observations, interviews and questionnaires distributed throughout the affected communities.

##### **4.2.1 Direct Observations**

During observational studies, researchers do not attempt to change or manipulate variables and factors being studied in any manner. Researchers observe and measure objects the way they are, this means observing variables in the natural untouched environment (Rosenbaum, 2011).

Observation is very important for both qualitative and quantitative research. According to Remler (2011), Qualitative data can be collected by just observing the natural environment and therefore most cost effective as much can be viewed in a reasonable amount of time. For qualitative research, observed data can be quantified and coded or rated for a specific situation and it should be noted that this method normally includes coding, counting and summarising observations.

### **4.2.2 Interviews**

The term interview is normally used or applied to a one on one interaction or one to many interactions which normally occurs where the researcher has created questions that allows for the interaction between people (Rugg and Petre, 2007). Semi structured interviews can be used as a guide with questions and topics that must be covered. The questions are normally standardised and ensures the researcher asks the correct questions. Semi structured interviews are often used when the researcher wants to engage much deeply on a certain topic to understand it thoroughly (Magaret *et al.*, 2009).

Semi structured interviews were used to elicit information on issues such as risk management, dealing with the impacts of climate change and strategies used by local government to reduce the impact of climate change on local communities. Candidates in the relevant departments were interviewed; members from the Department of Environmental Affairs and members from the Disaster Risk Management department were also interviewed.

### **4.2.3 Questionnaires**

A questionnaire can be used for research that results in the gathering of primary information. Questionnaires are often used as the best way of gathering information and views on certain topics. A questionnaire consists of a set of questions normally presented to a respondent. The respondent normally reads the questions and interprets them in their way then answers. Questionnaires are normally identified as the most flexible way of data collection (Marshall, 1998).

For research purposes, open-ended questions were used, these types of questionnaires allows the respondents to answer questions in much more depth, this therefore means that answers would not be standardised and data analysis of these results would need to be much more complex.

### **4.3 Secondary sources of data**

In order to get a better understanding of what the researcher has studied and can also be used for receiving information and relevant literature. For research purposes it is very advantageous to use data that has been previously collected and analysed by earlier researchers. Most of secondary data received is through or from official data archives and easy to retrieve (Hox *et al.*, 2005).

The following sources were used: published text books, reports from government agencies, published and unpublished work and valuable websites.

#### **4.4 Data analysis**

For the purpose of this research and in terms of the data analysis process the statistical package for social sciences (SPSS) version 24 was used to analyse statistical data and produce tables and graphs. In order for this to be successful data, needed to be classified and categorised, this is data received through the questionnaires distributed. Data is captured through reclassification and then coded and the analysis produced is pie charts, graphs and tables. Maps were also used as a data analysis tool. Coordinates of vulnerable areas were recorded, captured and processed using QGIS version 2.18.10 and maps were created. This chapter dealt with the research methods used in the study. The methods included both qualitative and quantitative methods as well as primary and secondary information. Semi structured interviews and surveys were used to elicit information from selected candidates. Data analysis included the use of a SPSS software version 24, QGIS version 2.18.10 and deductive analysis.

## **CHAPTER 5**

### **5.0 VULNERABLE COASTAL REGIONS OF COFFEE-BAY AND PORT ST JOHNS**

#### **5.1 INTRODUCTION**

This chapter of the research used geographical information systems to determine and analyse the areas of vulnerability as well as the resorts affected in these zones. Burton *et al*, (1993) mentions that it is a difficult task to measure and map populations vulnerability to an environmental phenomenon as populations have now occupied spaces that were previously inhabitable and prone to hazards.

#### **5.2 Presentation of results and data analysis**

##### **5.2.1 Materials and methods**

Field observations were conducted in both Port St Johns and Coffee-Bay to determine hotspots in the areas. Geographic Information Software QGIS version 2.8.10 was used to produce maps showing vulnerable areas located in the coastal zones. Maps were also used to locate resorts that were likely affected by a natural phenomenon. A camera was used to capture pictorial images of resorts located in sensitive zones. This chapter focuses on resorts located in geographical zones that were considered as sensitive zones by legislation. A 1km buffer is the legal requirement between the coastline and any development (The Integrated Coastal Management Act 24 of 2008)

##### **5.2.2 Results**

Geographic areas located near or along estuaries and low lying areas are most vulnerable to the impacts of climate change. Estuaries are most susceptible to flooding from excessive rainfall and storm surges, this having direct impact on coastal properties. Port St Johns is an area most vulnerable to these impacts as the town is entirely located in a low lying area surrounded by water bodies both by the Indian Ocean coastline as well as the uMzimvubu River.

Coffee Bay is relatively better than Port St Johns in terms of vulnerability, as it is more geographically situated with hills and valleys. Port St Johns is more vulnerable to impacts; vulnerability can be defined as the exposure of an event to an area, and how

much damage is caused (Watson *et al.*, 1999). Port St Johns experiences a higher degree of exposure and damage as compared to Coffee bay.

There are much more mountain ranges and hills although places close to the ocean, estuaries and rivers are susceptible to coastal flooding, storm surges and sea level rise. Coffee Bay and Port St Johns not only experience loss of property but also loss of major infrastructure such as overflow and loss of bridges which affects transportation routes and causes damaged roads and coastal erosion as well as eroded beaches leaves coastal property vulnerable to many impacts.

Results indicate that the impact Port St Johns experiences was much greater than that of Coffee- Bay. In April 2013, Port St Johns was declared a disaster region where approximately 15 out of 20 wards were affected by floods.

### **5.3 MAPPING VULNERABILITIES IN PORT ST JOHNS**

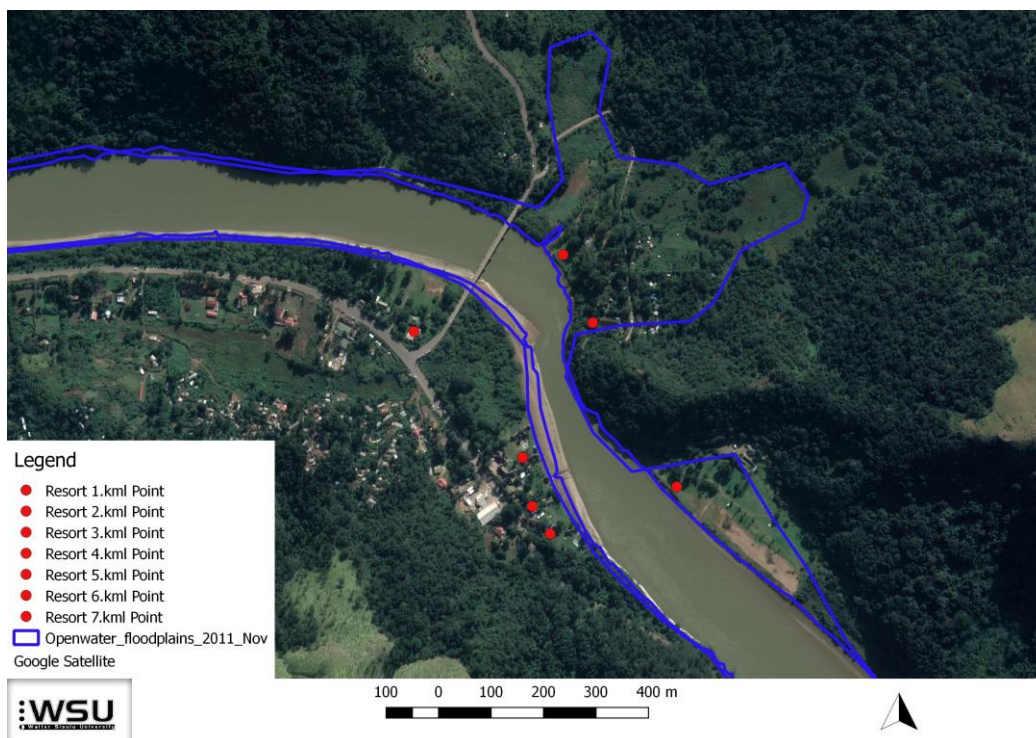
Geographical research indicates that resorts among the different locations are located in highly vulnerable areas. Figure 5.1 above represents the legislated 1km coastal zone as well as the 100m zone. From this map one can depict the resorts areas located in a geographical zone. Most of the coastal resorts identified as hotspots that have experienced the impacts of some kind, and are located within the sensitive zones.





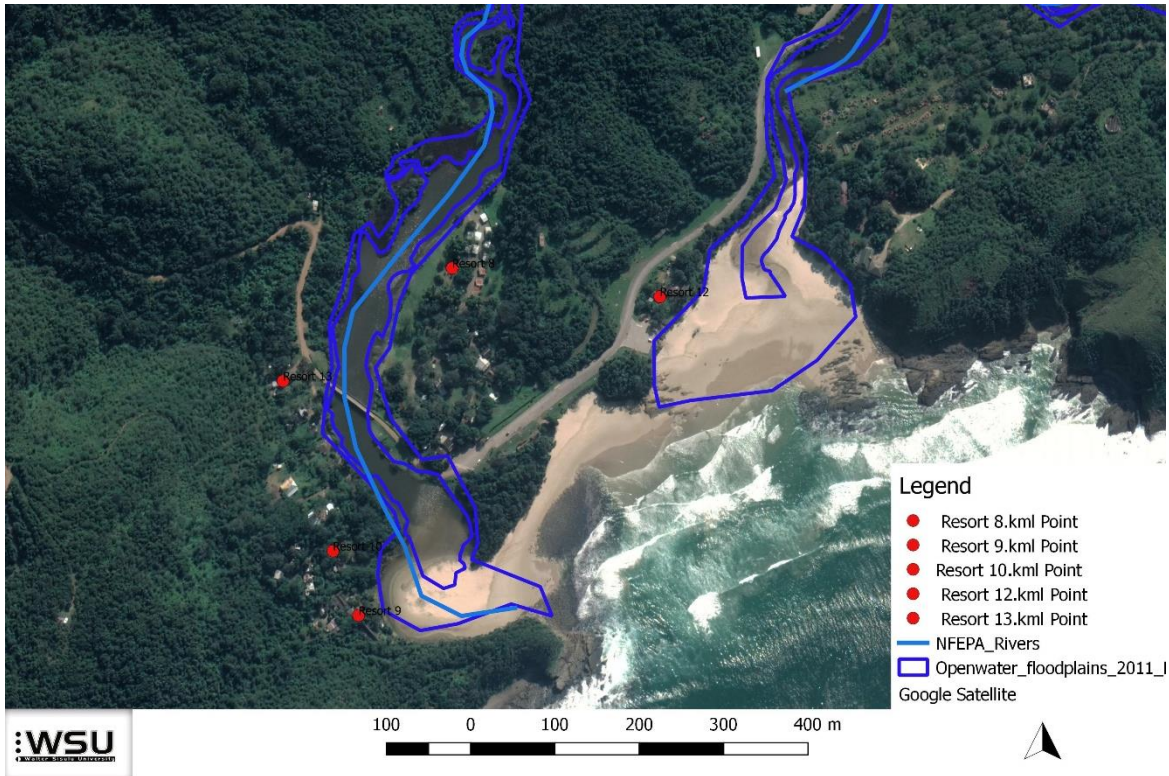
**Figure 5.1:** The Coastline and River banks of Port St Johns showing the 100m and 1km coastal zone.

The maps listed as figure 5.2 and 5.3 indicates the positions of resorts that are affected by an extreme weather phenomenon such as flooding or heavy rainfall in Port St Johns. This indicated some affected resorts located within a flood zone and some resorts not located within the flood zone areas due to the geographic location taken on the properties however still form part of the properties boundaries and still experience great impact. The resorts may not be located within the flood plain as shown on the map however, the location captured on the maps show the exact impact of floods on the property. The risk of vulnerability is higher in these zones, therefore exposure and sensitivity to a natural disaster is increased. Secondly, disasters may occur more often as most of these natural disasters occur seasonally, such as rainfall and storm surges which significantly impact coastal resorts. Thirdly, actions for adaptive measures have not yet been assessed and implemented where some resorts have opted to protect their properties which the department has declared illegal under the coastal act.



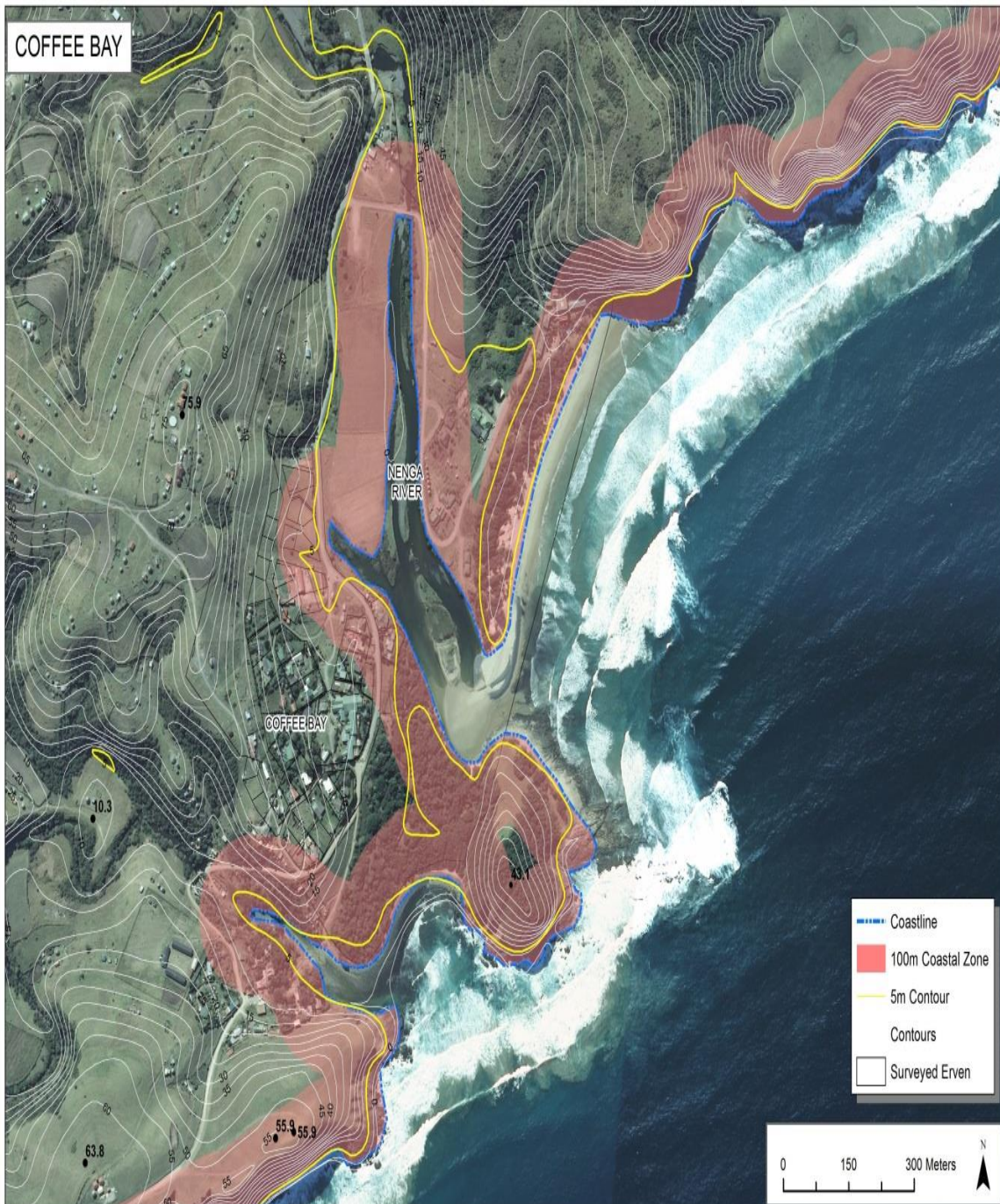
**Figure 5.2:** Resorts likely affected by a natural phenomenon at second beach, Port St Johns





**Figure 5.3:** Areas and resorts affected by flooding in Port St Johns

## 5.4 MAPPING VULNERABILITY IN COFFEE-BAY



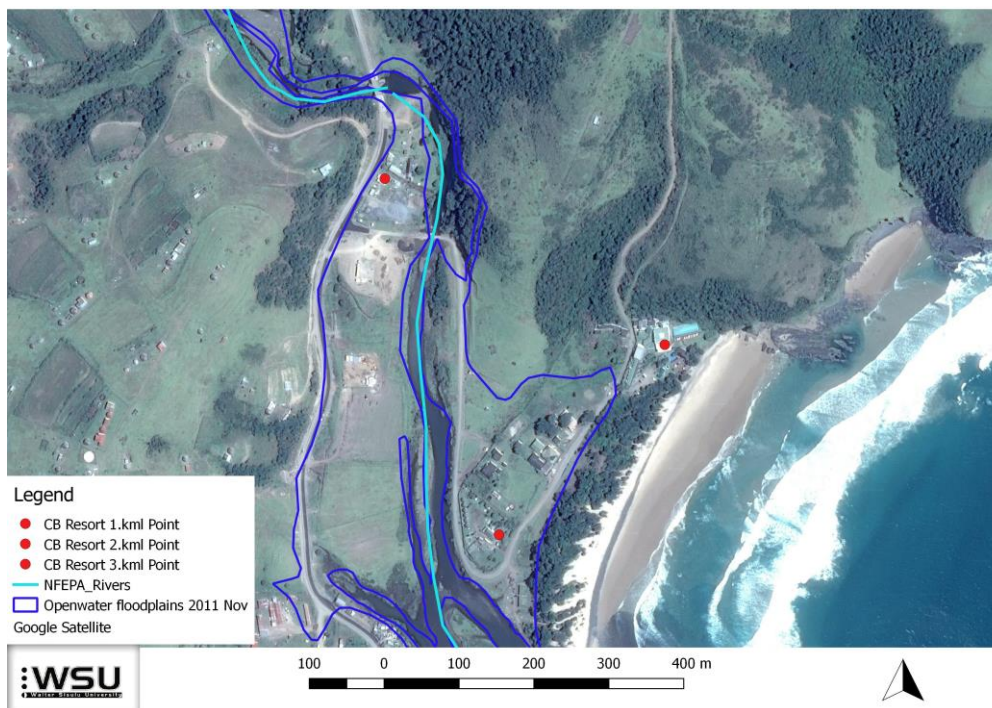
**Figure 5.4:** The Coastline and River banks of Coffee Bay showing the 100m coastal zone.



## 5.5 Discussion

The research focused on a specific guideline introduced by the United Nations Development Plan in 2010, which was a guideline for mapping climate change vulnerability and impact sessions. A similar approach was used to conduct investigations and analyse vulnerable zones. When conducting vulnerability assessments, the following indicators needs to be assessed. These include: exposure, sensitivity and the adaptive capacity of the region affected

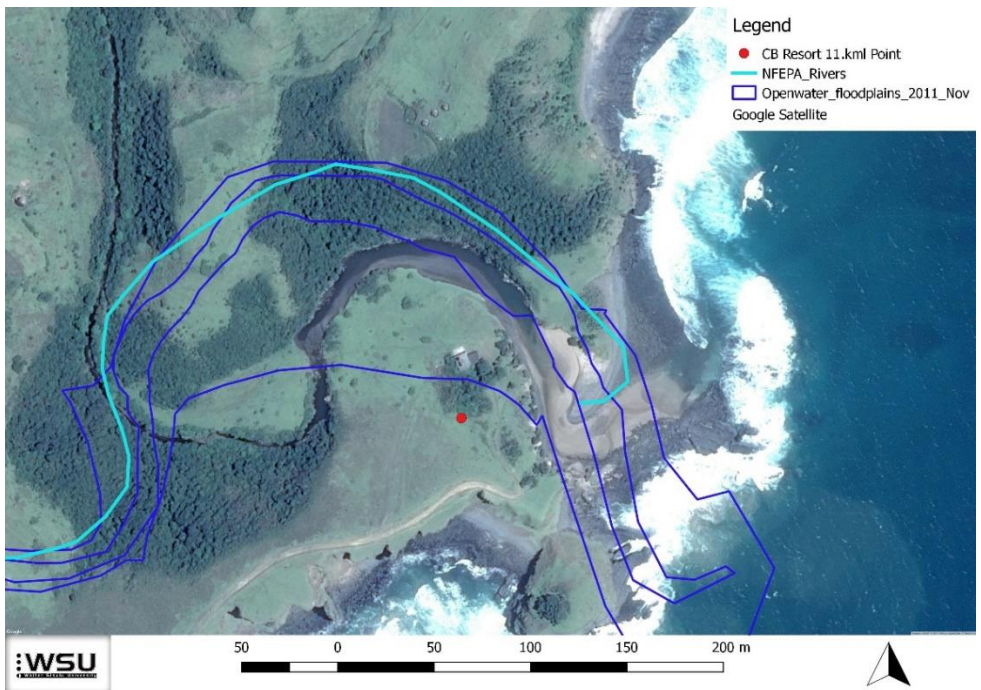
The positions listed in the figures denote the resorts affected by a climatic phenomenon in one way or the other. Figure 5.5 and shows tourism destinations located in Coffee Bay that are affected by either floods or tidal surges. This is just a view of the general position and location of some of the resorts affected in Coffee Bay. Figure 5.6 and Figure 5.7 shows resorts affected by weather phenomenon's such as flooding however these are not found within the floodplain boundaries of the Eastern Cape, 2011. This poses the question on whether or not, the floodplain for the Eastern Cape open waters needs to be reassessed and evaluated.



**Figure 5.5:** Resorts vulnerable to impacts of climate change in Coffee-Bay



**Figure 5.6:** Position of affected resorts located along an estuary in Coffee- Bay.



**Figure 5.7:** Positions of affected resorts along Mthatha Mouth Coastline near Coffee bay.

### **Past and Present impacts.**

Exposure is assessed as the past, current and future projections related of climate related conditions. Past and present weather phenomena or hazards are recorded to show and investigate their likelihood of reoccurring. History shows an increase of significant rainy days across the regions of the Eastern Cape between the years 1960-2000, with temperatures reaching average maximum increase of 0,017 °C/ year and 0, 03°C / year all seasons largely as a result of above average (MacKellar *et al.*, 2014). Future climate projections for South Africa recorded by Englebrecht *et al.*,(2013) described in the AR4 report of the IPCC shows a projected increase in the median temperatures of more than 2°C across the coastal region of South Africa and an increase in the median of rainfall over the Eastern parts of South Africa

### **Sensitivity**

The areas sensitivity relates to the level of tolerance for the different areas, how these areas are impacted by certain hazards and how they are tolerant to the impact (Parry, 2007).The more frequent and intense the conditions, the greater the sensitivity of the region, the greater the impact on communities. South Africa is susceptible to extreme weather patterns mainly through floods, extreme storms, drought and wildfires. South Africa's risk and sensitivity increases due to the regions exposure to the extreme weather conditions (Davis-Reddy *et al.*, 2017) In the case of Port St Johns and Coffee Bay, because these areas are located along the same coastline, the impacts are very similar. Heavy rainfall for example would be experienced in both regions and normally at the same time.

### **Adaptive capacity**

Adaptive capacity is measured as the ability of a community or society ability to cope and manage with the changes of a hazard (Kates *et al.*, 2001). It is vital for one to assess coastal vulnerability and the ecological capacity of the coastal system to ensure sufficient planning and mitigation (Whitney *et al.*, 2017). This factor deals with the readiness of a community to anticipate a certain phenomenon as well as to cope with it and respond to the impacts. The physical environment between Port St Johns and Coffee-Bay is similar, however it affects different social classes, not many resort owners have the ability to respond to and mitigate the impacts of a certain phenomenon.

## **5.6 Conclusion**

Results show the areas greatly affected by climatic conditions. It also shows the area's most vulnerable to the impacts of climate change conditions, these areas include resorts located near estuaries, near river banks and those close to coastal set back lines and even those located in the 100km coastal zone. A realistic phenomena to be studied is that climate change may greatly impact the South African coastline with impacts that could mover further inland therefore placing resorts at even greater risks.



## **CHAPTER 6**

### **6.0 COASTAL RESORT OWNERS PERCEPTIONS TO CLIMATE CHANGE**

#### **6.1 INTRODUCTION**

This chapter was carried out to determine the way people specifically those who own coastal homes and resorts perceive climate change and its impacts on their properties. This chapter also dealt with the way people deal with these risks and vulnerabilities as well their preparedness for these impacts.

#### **6.2 Presentation of results and data analysis**

This chapter specifically focused on the coastal communities such as coastal resorts, homes and hotels that are located within close proximity to the coastline as well as those located in low lying areas of coast and rivers.

In order to receive valuable information with regard to people's perceptions on climate change and its impacts, data collection was carried out through questionnaires which were distributed among coastal resort owners along selected Wild Coast areas, which included Port St Johns and Coffee Bay. The spss version 24 software was used to process data and elicit valuable data.

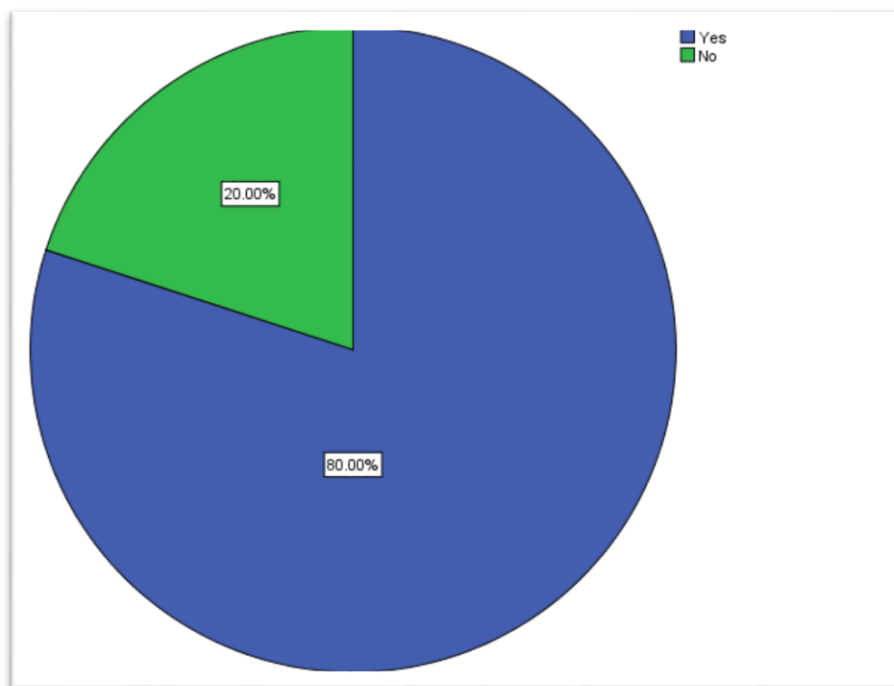
##### **6.2.1 Results**

Results show that climate change is a phenomena that is greatly recognised by many people and although it's an issue of global concern, many recognise that it's an issue that should be dealt with from the smallest of scales. And that many owners understand that climate change may worsen for years to come.

Resort owners were asked on their understanding on environmental issues, the following results were deducted. 75% of owners understood global environmental issues, with 25% understanding it very well. When asked about their understanding of climate change, 80% of owners said they fairly understand the phenomenon and only 20% understood it very well.

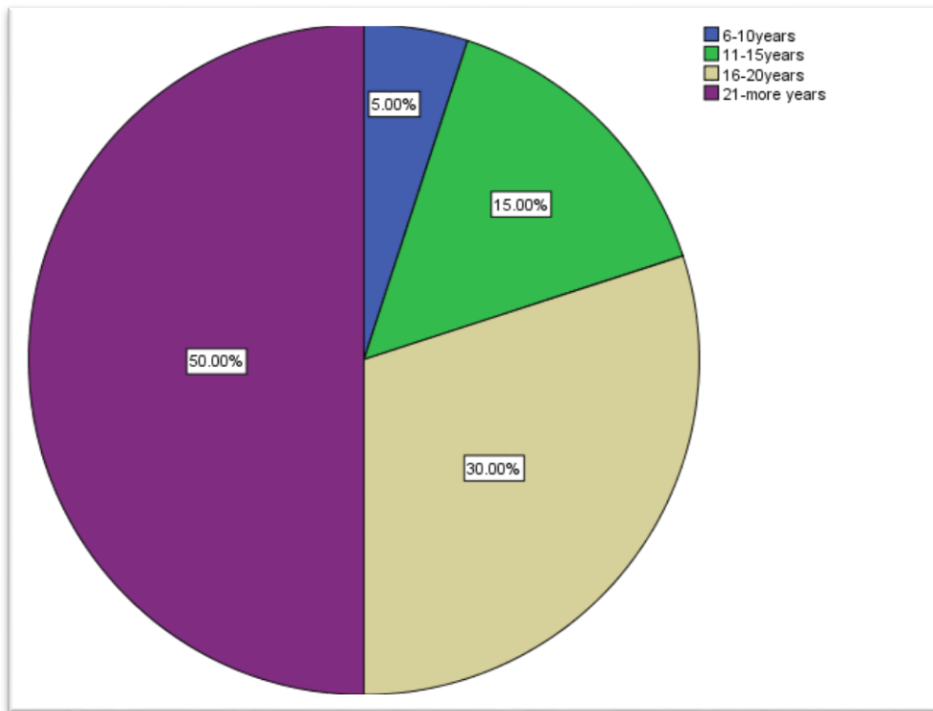
Although these property owners along the wild coast understood the risks of living in close proximity to the coastline or even in zones that are threatened by the idea of extreme weather conditions as seen in figure 6.1, it does not redirect the value that comes with living along these pristine beaches. The social benefit of being near the

ocean that even brings a sense of tranquillity greatly exceeds any climatic condition. This is a misleading perception that many have. The impact of climate change can affect resorts from a small scale of a basic storm to detrimental impacts such as tsunamis, and thus not only affecting coastal properties but also on people's lives. However from the results one can understand that many properties along the coastline have been generational, thus meaning that they have been around for decades.



**Figure 6.1:** Understanding the risk of coastal living.

These properties have been passed down generations of families and have been around for almost 100 of years. Figure 6.2 shows that almost 50% of the coastal properties have been built and established over 21 years ago. These resorts were mostly established between the 1200's and 1600's. It should be noted that most of these properties are located within sensitive areas of the coast line and therefore are at greater risks to the impact of climate change.



**Figure 6.2:** The years which the property was established.

The Department of Land Affairs, now Rural Development and Land Reform recognises that districts in this Eastern Cape region, most of the land is either government-owned (national and local), or falls under a tribal authority. Legal forms of land tenure in the district include: freehold (mainly concentrated in the urban centres or townships, certain shops in rural areas, providing security to the owner), Permission-To-Occupy (mainly in the rural owners where there is no right of ownership), leasehold and grazing rights on commonage.

### **6.2.2. Extreme weather events and their impacts**

The major impacts that affect our coastal environments include conditions such as increased storm severities, increased storm surges that are coupled with sea level rise thus resulting in coastal flooding. Storm surges accompanied with tidal waves is another major concern for coastal environments. Coastal areas are also susceptible to heavy rainfalls and with issues such as catchment hardening results in flooding of coastal towns. Heat waves and drought coupled with fires can also have a detrimental impact on coastal properties. Freak incidences such as tsunamis and hurricanes may also have a detrimental impact on coastal environments. Figure 6.5 to figure 6.7 shows damaged resorts in Port St Johns due to their exposure of floods and extreme storm

surges. Table 1 depicts the phenomenon as well as its likelihood of impact and its major impact on coastal resorts.

**Table 6.1:** Impact status to coastal resorts in both Port St Johns and Coffee-Bay

<b>Phenomenon or weather trend</b>	<b>Likelihood of impact</b>	<b>Major impact of coastal resorts</b>
Rainfall(Heavy precipitation)	Intensified rainfall projections are likely to occur along the identified coastlines	This has a major impact on coastal resorts with loss and damage of property.
Drought coupled with fires	Intensified drought is recognised along the Eastern Cape but the likelihood of fires is minimal along coastlines.	No major impacts on coastal resorts especially those located in Coffee Bay and Port St Johns.
Intense Storms and storm surges	Storm surges coupled with tidal waves have significant impact on coastal areas and great likelihood to occur along the Wild Coast with great impact on areas such as Coffee Bay	Settlements located in low lying coastal zones as well as areas such as estuaries are at risk of storms with major loss and damage to property.

Floods	Floods can be caused by a rainfall phenomenon or storm surge. The Wild Coast is greatly impacted by coastal flooding especially Port St Johns as the town is located in a low lying area	Flooding can result in much damage to property, damage to infrastructure with other major indirect losses as well as loss of river banks.
Coastal Erosion	The coastline is susceptible to coastal erosion as an impact caused by human induced activities and climate change	No physical damage to settlements but destruction of land property and loss of land.
Sea Level Rise	Although there is no direct evidence of sea level rise the phenomenon exists and greatly impacts coastal areas	Major impact on coastal property with major impact on properties located along estuaries and low coastal zones.



**Figure 6.3:** Flooded Umvimvubo River and submerged resorts.



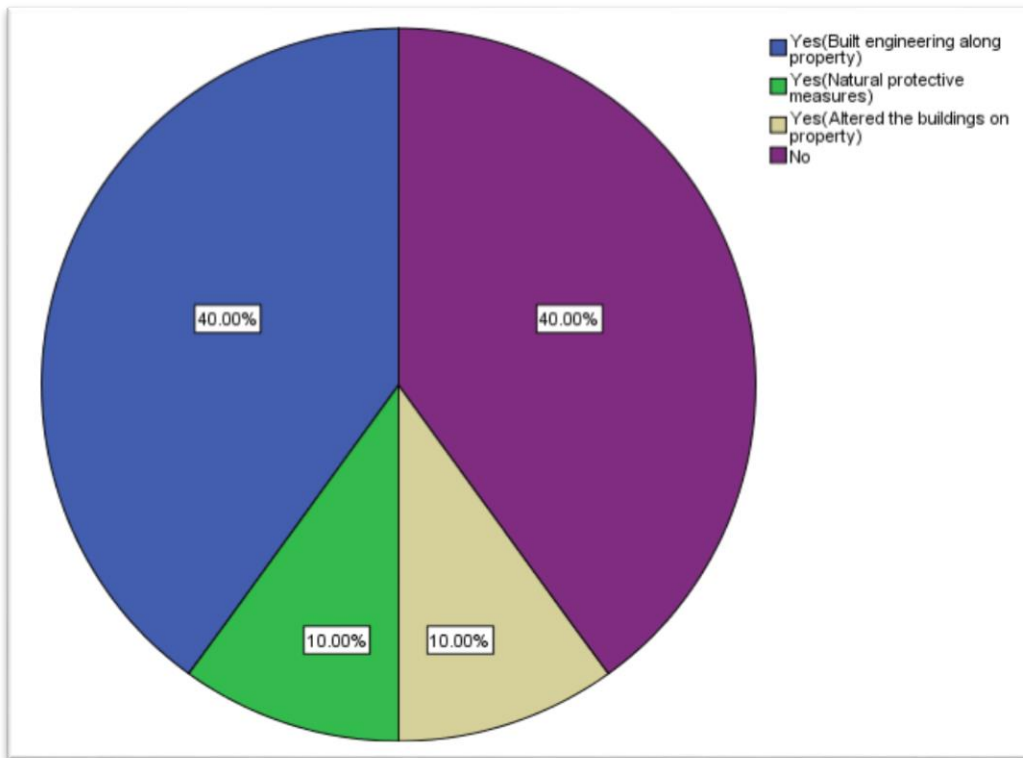
**Figure 6.4:** Flooded Port St Johns resorts along the Umvimvubo River

### **6.2.2.3 Coastal protection adopted by resort owners**

Present and forecast sea level rise, and an increase in the frequency and force of coastal storms resulting from climate change, are likely to mean that coastal defence efforts will become increasingly necessary to protect against erosion and flooding.

The study revealed that although coastal protection is a priority for people to adopt, many owners have adopted fascinating techniques that try to keep the environment as natural as possible and have developed certain natural techniques that protect their property from adverse impacts of climate change. This can be identified as soft engineering as seen in figure 6.5 with 10% of resort owners using natural defences for their protection. Soft engineering is the construction of materials which try to work with the natural environment by manipulating natural systems which can adapt to the energy of the waves, tides and wind. This approach has economic benefits while minimising the environmental impact of traditional engineering structures. The methods which can be used include processes such as artificial nourishment. Many resort owners have opted to use soft engineering as a defence mechanism. This included processes and activities such as reclaiming land and banks, this is achieved by extensive soiling of the banks of rivers thus to create river bank stability. After this is achieved, access to the part of the land is prohibited meaning that one cannot use that area for development or even for activities such as camping or car parking as shown in figure 6.6 and figure 6.7.





**Figure 6.5:** Preparedness against damage caused by climate change.



**Figure 6.6:** Reclaimed land after flooding in Port St Johns.





**Figure 6.7:** No vehicles allowed on the banks of the river.

Some resort owners have created a nursery project on their properties with the hope that this activity would act as a filtration system in cases of excessive rainfall thus decreasing runoff on properties. Figure 6.8 shows how vegetation and plants are used as a method of soft engineering



**Figure 6.8:** Nursery as a method of soft engineering

Although some have opted to value the environment many other resorts have chosen to have a much more stable take to coastal protection and have constructed very complex engineered methods. This can be referred to as hard engineering methods.

This is defined as the building of structures which aim to control and resist the energy and impact of the waves and tides. Such structures include: breakwaters and seawalls are created and used to minimise wave energy inputs; groynes are designed to establish and increase sediment storage; and flood embankments and barrages designed as water-tight barriers. Boulders have been placed along the banks of rivers and estuaries this is done to prevent loss of property or damage thereof from impacts such as floods and tidal waves. Figure 6.10, figure 6.11 and figure 6.12 show the measures coastal resorts have used in trying to protect their properties



**Figure 6.9:** Resort located along an estuary in Port St Johns





**Figure 6.10:** Wall built along an estuary in Coffee Bay



**Figure 6.11:** Wall built at a resort along the Umvimvubo River, Port St Johns



**Figure 6.12:** Concrete walls used as a preventive measure against floods.

The decision to have these built has resulted the involvement of the Department of Economic Development, Environmental Affairs and Tourism of the Eastern Cape, as such an activity is considered as unlawful unless a permit is issued in conjunction with the application submitted. In this case no application has been received by the department for the construction of such walls by these resorts.

The establishment of coastal set back lines is issued in accordance with this in **Section 25** of the Integrated Coastal Management Act which states that

- (1) An MEC must in regulations published in the Gazette—
  - (a) establish or change coastal set-back lines—
    - (i) to protect coastal public property, private property and public safety;
    - (ii) to protect the coastal protection zone;
    - (iii) to preserve the aesthetic values of the coastal zone; or
    - (iv) for any other reason consistent with the objectives of this Act; and
  - (b) prohibit or restrict the building, erection, alteration or extension of structures that are wholly or partially seaward of that coastal set-back line.

Regardless of the law clearly stating the restrictions to the erection of certain structures, these structures still exist and as a result notices were issues according to this Act. The Act states in **section 60** that:

(1) The Minister or MEC, may issue a written repair or removal notice to any person responsible for a structure on or within the coastal zone if that structure—

- (a) is having or is likely to have an adverse effect on the coastal environment by virtue of its existence, because of its condition or because it has been abandoned; or
- (b) has been erected, constructed or upgraded in contravention of this Act or any other law.

The person wholly responsible for erecting a structure and who is found to have contravened this Act is given the opportunity to appeal against this notice, although failure to comply to any of the notices may result in the following according to this Act. Section 61 of the Act mentions the indications of failing to comply to notices. If a person fails to comply with a notice issued in terms of section 59(1) or (5) or section 60(1) which requires that person to carry out any specific action, or if the person responsible is not identified after publication of a notice in terms of section 60(5), the Minister or the MEC who issued the notice may instruct appropriate persons to—

- (a) Carry out what is required by the notice; and
- (b) Recover from the person to whom the notice was addressed, or in the circumstances referred to in section 60(4) from any person subsequently found to be responsible for the structure, the costs reasonably incurred in carrying out the required action.

In other instances, some resorts have chosen a much more different approach in preparation for any extreme weather event with more consideration placed on coastal flooding. Some resorts have opted to change the structures of buildings to ensure minimum damage on property in the event of an extreme weather event. Resorts are built somewhat elevated from the ground. Resorts in Port St Johns are very familiar with this technique as this is a coastal town prone to flooding. Figure 6.13 shows a coastal resort in Port St Johns that has used this technique. This resort in particular has experienced extensive damage over the years caused by flooding.

A few have even created and designed buildings in such a way to withstand any weather occurrence, from a basic wind storm to floods. This is achieved by reconstructing building with tougher materials. Buildings are built with metal through



walls in achieving a stronger, stable foundation and building for freak climatic conditions.



**Figure 6.13:** Elevated resorts in Port St Johns.

Results show that much of the confusion resulting from coastal boundaries, set back lines and the situation of the constructed walls arises due to the fact that the resort owners interviewed for the purpose of this research have all suggested that one cannot depend on the accountability of the Department of Environmental Affairs nor that of the Risk Management Team of the accounted areas. All resort owners have rated these departments to have no value and ethics for people living along coastal areas. Many people are unaware of the laws governing the coasts therefore much confusion occurs amongst communities and relevant stakeholders and departments. There is a great need for environmental education especially in rural communities and especially based on the topic of climate change. Another alarming situation is that communities do not know how to deal with the impacts of a natural disaster. People are not educated or made aware in the event of a possible disaster and this is a concerning issue especially in Port St Johns as this is a coastal town prone to disasters due to its geographical positioning.

### **6.3 Conclusion**

This chapter has dealt with the aspects of climate change and how coastal resorts owners perceive its importance as well as the risk posed of owning a resort in a vulnerable coastal area. It also examines the preparedness of these communities to any climatic condition that could be detrimental to their properties and livelihoods.

The following key issues were outlined from the results;

People generally have an idea of climate change and the risk it poses on coastal communities.

The coastline is affected by conditions such as storms, heavy rainfall which inevitably results in coastal flooding.

There is no relationship with the relevant departments.

### **6.4 Recommendations**

There is a great need for environmental coastal protection as well as climate education among coastal communities. Awareness and education is an important tool in achieving successful coastal protection.

There should be a proactive community plan from relevant departments ensuring a response strategy is designed and implemented based on the risk level of the coastal areas.

There is a need for developing or enhancing natural coastal defences in protecting coastal communities. The wild coast faces an increasing act of sand mining thus inevitably destroying the coasts natural defence mechanisms.

Approaches and strategies for high risk properties should be considered, where hard engineering should be considered for long term coastal planning and protection.

Resort owners can also develop and improve infrastructure that would withstand severe weather conditions.

## **CHAPTER 7**

### **7.0 LAWS GOVERNING COASTAL PROTECTION FROM GOVERNMENT OFFICIALS**

#### **7.1 INTRODUCTION**

Climate change is a global concern and its effects are being experienced around the world, different changes are being observed and these conditions are expected to increase and change in scale and scope over the next years or even decades (The Department of Environmental Affairs, 2011).

It is therefore important that everyone starts implementing and mitigating climate change, therefore setting up adaptation measures becomes an increasing concern at all government levels. Global warming may result in substantial change with adverse effects on coastal zones therefore we must adapt and plan for these changes and who better to start an initiative than government officials.

This chapter was carried out to determine the local municipalities' plans in implementing adaptation approaches as well as their views regarding laws and regulations regarding coastal protection. The ultimate goal of this chapter is to determine whether or not local departments have planned and organised tools to protect coastal communities to the impacts of climate change.

#### **7.2 Materials and methods**

In order to elicit information from government officials on the state of climate change and its impacts on the Transkei coastline, data was collected and executed through questionnaires which were distributed to officials from DEDEAT as well as the disaster risk management team of the O.R. Tambo District. The SPSS version software was then used to analyse and interpret data gathered from the questionnaires.

#### **7.3 Government Officials rating climate change for Wild Coast**

Climate change is a global phenomenon its impacts are experienced at a local level. Officials interviewed stated that climate change is already a reality and a measurable phenomenon that impacts greatly along developing countries with major impact on the South African coastline especially areas vulnerable to sea level rise and estuaries. Human settlements are most vulnerable to these impacts. The impacts on the Wild Coast coastline include increased storm surges and are usually coupled with sea level rise and the resultant impact is coastal flooding. The coastline is also vulnerable to



intensified rainfall and these results in severe impacts both by climatic conditions as well as hardened catchment areas which directly impacts or becomes a threat to coastal infrastructure.

### **7.3.1 Approaches used in ensuring coastal protection**

In order to achieve an effective plan to coastal protection, there needs to be a clear response plan in dealing with climate change at a local scale. The Eastern Cape Climate Change Response Strategy was implemented and established to combat such crises. This document was drafted in March 2011 with the following aims being prioritised for the Eastern Cape.

This document gives an outline of climate conditions affecting the Eastern Cape Province as well as its coastline, the risks and its impacts as well as the adaptation and response strategy. As such the Eastern Cape response strategy includes a risk assessment matrix which aims at facilitating a step by step guide to understanding climate change and its impacts that may affect the province and the severity of these problems.

The Department of Environmental Affairs in the O.R. Tambo District notes a number of long term approaches and goals that can be planned, created and implemented by local officials not only in the Eastern Cape but as for South Africa as a whole. The following approaches were noted during the interview;

1. Local departments should formulate responses for climate change based on a monitoring system, this would mean that local government would need to develop a monitoring facility that would provide climatic variables and measurable scales and this would allow necessary protection steps taken according to scales and coastal areas.
2. Proper planning should also be implemented not only through an environmental aspect but through local municipalities such as spatial planning of the Wild Coast by SDF of municipality through the wild coast management plan.
3. Traditional authorities need to show contribution towards developmental planning especially around coastal rural areas where coastal land is predominately controlled by traditional communities.

4. Recently the DEDEAT has put the Transkei Decree No 9 of 1992 in full effect which stipulates that no development shall commence within 1000 metres from the coastline without a permit.
5. Setback lines is established by the Coastal Management Act thus to prevent development and detrimental acts along the coastlines.
6. The Department of Environmental Affairs has developed a plan for coastal protection, this is called the Wild Coast Environmental Management plan and this plan seeks to regulate coastal zoning and developments as well as to curb all illegal developments particularly those located in environmental sensitive areas.
7. Other approaches recently includes the development plans of dams impounding major drainage systems such as Umvimvubu River (Port St Johns) by building dams which will decrease the flow of water towards the coast reducing the impacts of flooding.

### **7.3.2 The challenges faced in ensuring the implementation and protection of coastal areas**

There are a number of issues faced by the local officials in ensuring coastal protection as well as the implementation of laws, this resulting in a major issue for controlling the impacts of climate change on coastal settlements. There are a number of major issues recognised by local officials. The DEDEAT recognises the following problems and recognises the most urgent conditions which requires immediate action to reduce the deterioration of the Wild Coast.

1. Many sites along the Wild Coast are considered as unplanned and located in areas that are considered as sensitive zones, illegal developments along the Wild Coast is still a continuous issue. This is also due to the issue of traditional authority controlling land ownership along coastal areas.
2. The destruction of natural environments along the coastline as a major issue for local government. The Wild Coast experiences a number of situations, this includes the destruction of mangroves through deforestation as well as the sand dune destabilisation due to sand mining, this reduces the natural ability of the environment to minimise the impacts of severe conditions such as coastal flooding.

3. Another issue recognised is that much of strategies are discussed and planned but not many are implemented and put into action by local officials. There is a great need for monitoring officials especially personnel experienced in the climate change field.

### **7.3.3. Policy principles identified for Wild Coast**

The DEDEAT has introduced and planned a number of issues that has identified the key policy proposals for the Wild Coast, this in accordance with climate change can be used as key measurements to control and protect coastal zones against climate change impacts, therefore these policy principles may act as a guide to minimising the impacts of extreme weather conditions on coastal resorts along the Wild Coast.

1. Increasing nodal development sites is a priority. This is necessary to introduce as this allows for the increase of developments within legal nodal points and therefore creates a balance between environmental protection and coastal development. This also controls the increase of developments located outside of the nodal zones.
2. Historical coastal settlements creates a scenario among local authority and cottage owners. The settlements corridor introduced after 1992 which is the establishment of the 1km corridor zone should be formalised and implemented. Development that existed prior to this law should not spread further into the corridor; therefore limitations of development should be prioritised to ensure no damage of settlements to climate change.
3. Illegal developments is another challenge that should be prioritised therefore the DEDEAT has developed programs that intensify the control of illegal developments along coastal areas. This policy ensures measures are taken to reduce development of illegal sites along the Wild Coast but it is important to note that this works hand in hand with environmental education and awareness.
4. Estuaries have become a favourable environment for developers therefore the state of under developed estuaries should remain pristine and therefore the 100m buffer zone should be retained and this includes estuary bank development as well.

For the reason of climate change the 100m buffer between estuaries and high water marks and development should be retained. It is inevitable that development near these zones and sensitive zones will be susceptible to the impacts of climate change. These zones are mostly affected by coastal flooding, sea level rise and severe storms.

#### **7.3.4 Adaptation measures used by the local environmental department**

Adaptation is a complex phenomenon and it deals with measures used to ensure protection through ones preparedness and the capacity available to understand ones risk.

The study had revealed a number of adaptation measures used or in the process of implementation used to ensure the protection of areas along the Wild Coast against the impacts of climate change. The following have been prioritised.

1. The department of Environmental Affairs recognise the need for country wide monitoring of climate change, this can then be used as a scale basis on a local level to study and investigate the measures used for a certain phenomenon.
2. The Department of Environmental Affairs is also in the process of engineering a dam to minimise the flow of rainfall into the Umvimvubo River thus reducing the impacts of floods in Port St Johns.

#### **7.3.5 Additional adaptation that should be considered by the local government (Recommendations)**

The adaptation of bi-laws should be greatly considered and implemented with the focus on climate change and coastal development. Here the local government should implement policies that localise a certain impact for a certain region such as focusing on coastal flooding and sea level rise for Coffee Bay and Port St Johns.

Prioritising climate change in land use planning is another policy that could be used to facilitate set back lines and flood plains therefore no new or additional developments may occur in sensitive zones of the coastline.

Studying areas associated with risks through map work is another adaptive measure the department could implement. This would include local areas mapped to show susceptible areas, areas that for example could be affected by floods or even erosion and therefore these mapping techniques could be used to recognise areas not acceptable for development.

Implementing awareness becomes an important priority for coastal protection. Educating citizens of the impacts of climate change as well as their risks is important in ensuring people take the necessary yet environmentally sound decisions in protecting their properties.

Educating and encouraging local resort owners to take up more environmentally sound measures and also involving the community at large in campaigns such as reforestation of mangroves, re-vegetation of coastal areas as well as involving the community in tasks such as monitoring the removal of sediments of rivers and coasts thus improving the coastline and also restoring its natural ability to protect itself against extreme weather conditions,

The local government should also implement an emergency response plan. This includes setting up strategies that result in quick responsive and recovery measures for before, during and after a major disaster occurrence. The study had revealed that resort owners were not aware of the Disaster Risk Management team or neither Coffee Bay or Port St Johns, this would need a major shift.

#### **7.4 Conclusion**

This chapter dealt with the laws and principles used by the local government in ensuring coastal protection is achieved and implemented. It also dealt with the adaptation measures used by local government in ensuring the protection of coastal communities to the impacts of climate change. This chapter revealed a number of challenges faced by the local government in ensuring a successful coastal plan is maintained. Adaptation measures have also been put into action to combat these challenges some only have just been documented others are adaptation measures that should be initiated or used to ensure coastal protection and the protection of coastal communities.

The following key issues should be noted in this chapter

A clear plan needs to be established by local government to deal with climate change at a local level.

Local resorts are predominately controlled by traditional authorities with historical ownership therefore placing a challenge on local government for environmental planning.

Set back lines (coastal zoning) should be established, implemented and controlled especially along estuaries and other sensitive zones.

Education and awareness is a priority for local government, this creates a platform for government to communicate and teach communities about environmental phenomena's that affect them and how they could possibly deal with it in an environmentally sound manner, working together to ensure coastal protection and social improvements.

## **CHAPTER 8**

### **8.0 OVERALL CONCLUSION AND RECOMMENDATIONS**

#### **8.1 INTRODUCTION**

Human settlements along the coastline will inevitably be affected some way or the other by the impacts of climate change. Research along the Wild Coast of South Africa has been minimal and predictions have been assessed rather at a national level although the areas the coastline have experienced some detrimental conditions which in one form or another is caused and can be intensified by climate change.

The Wild Coast coastline experiences a number of weather conditions that greatly impacts resorts located along or near vulnerable areas, these conditions include increased storm surges, usually coupled with sea level rise and intensified rainfall which results in coastal flooding.

The study revealed that areas geographically located along estuaries, near rivers and within the coastal zone boundary is most vulnerable to these impacts. Regardless of the reality of these impacts, people are still drawn to coastal living; this does not change their perceptions of living near the coast. Another interesting result revealed during the study, is that most of the properties along the coastline are owned through tribal authorities and permitted and leased to owners through Permission to Occupy (PTO's) placing a great challenge for local government in ensuring the protection of coastal communities.

The study also revealed measures used by local communities and resort owners in attempt to protect their properties against the impacts of extreme weather conditions thus ensuring their readiness and preparedness for the next disaster. A few have adopted natural measures also scientifically known as soft engineering through acts such as river bank stabilisation while other resort owners opted for more structural protection also known as hard engineering, where these actions are against certain coastal laws of South Africa and resulted in conflict among local resort owners and local government.

Local government have mentioned that climate change along the Wild Coast is a reality and a measureable phenomenon and therefore the Climate Change Response Strategy was established and introduced to work as a tool providing local government principles that should be followed to implement adaptation and response strategies at local levels. Although there a number of strategies put in place to ensure the effectiveness of this plan, there are a number of challenges faced by local authorities, these include major challenges such as illegal developments found along the coastline with these developments located in environmentally sensitive areas. Another major challenge faced is the destruction of natural habitats along the coastline. Sand dune destruction is a major issue for both Coffee-bay and Port St Johns thus increasing the risk of impacts of climate change on coastal developments.

The DEDEAT have recognised the need to identify these challenges and create and establish policies that encourage coastal protection and adaptation measures against extreme weather conditions. These include developing the coastline into nodal categories which encourage development within legal boundaries. The 1km coastal zone will be placed into full implementation with monitoring placed on developments that already occur within this zone; with the law stating that there should no spread of development should occur within this zone. A 100m buffer zone will be retained to ensure estuaries remain under- developed and pristine along these areas of the Wild Coast.

## **8.2 Recommendations**

There is a great need for environmental awareness that should educate people on issues such as climate change and their vulnerability as well as educating people on approaches that would be beneficial for both communities and the environment.

There is a need for the establishment of bi-laws at local levels of environmental departments, disaster risk management and local government as these decreases the applications of theoretical principles which could contradict realistic phenomena's.

Establish a high level and joint operation amongst the different stake holders, this including local government, tribal authorities and affected communities in ensuring a joint understanding of environmental principles.

Rehabilitating coastal areas to restore the coastal natural ability to withstand severe weather conditions.



Implementing set back lines along nodal areas for both Coffee-Bay and Port St Johns. Prioritise climate change at a local level and introduce monitoring facilities at local environmental departments. Reassessing the flood plain or open water plains zones and setbacks for these regions would be beneficial for further development practices. The Disaster Risk Management should establish a comprehensive working response and recovery plan to ensure affected communities are warned, prepared and recovered during and after a coastal disaster.

## REFERENCES

Aguado, E and Burt, J. (2007). *Understanding Weather and Climate*. 4<sup>th</sup> Edition. Pearson Inc. United States of America.

Allanson, B.R and D. Baird. 1999. *Estuaries of South Africa*, Cambridge University Press. Cambridge. UK.

Annexure 5- District Profile: O.R. Tambo District Municipality, DC15. Eastern Cape. South Africa.

Bijlsma, L., C.N. Ehler, R.J.T. Klein, S.M. Kulshrestha, R.F. McLean, N. Mimura, R.J. Nicholls, L.A. Nurse, H. Pérez Nieto, E.Z. Stakhiv, R.K. Turner and R.A. Warrick. 1996. Coastal zones and small islands. In: *Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*, R.T. Watson, M.C. Zinyowera and R.H. Moss (eds.). Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA, pp 289-324.

Bindoff, N.L, J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quere, S. Levitus, Y. Norjiri, C.K. Shum, L.D and A. Unnikrishnan, 2007. Observation of oceanic climate change and sea level. The physical science basis. Contribution of working group I to the fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA.

Breetzke, T., O. Parak and L. Celliers, 2008. *Living with coastal erosion*. Department of Agricultural and Environmental Affairs. KwaZulu Natal. South Africa.

Burton, I. 1997: Vulnerability and adaptive response in the context of climate and climate change. *Climatic Change*, 36:1.185–196.

Cabane, C., A. Cazenave, 2001. Sea level rise during the past 40 years determined from satellites and in situ observations. *Science*. Christian Le Provost, 294:5543. 840-842.

Canadian- Climate Impacts and Adaptation Research Network, 2006: National Resources Canada. Environmental Canada, European Commission.

Cartwright, A. 2012. *Coastal Vulnerability in the context of climate change. A South African Perspective*. South Africa.

Davis-Reddy, C and Vincent, K. 2017. Climate Risk and Vulnerability. A handbook of Southern Africa. 2<sup>nd</sup> Edition. CSIR. Pretoria. South Africa.

Department of Economic Development and Environmental Affairs and Tourism. 2012. The draft of Spatial and Environmental Management Guidelines for the Wild Coast of the Eastern Cape Province. Discussion Document for Public Consultation. Republic of South Africa.

Department of Economic Development and Environmental Affairs. 2013. Draft Spatial and Environmental Management guidelines for the Wild Coast of the Eastern Cape Province. Discussion document for public consultation. Eastern Cape. South Africa.

Department of Environmental Affairs and Tourism. 2006. The Integrated Coastal Management Bill, A brief Guide to assist the public participation process. South Africa.

Department of Environmental Affairs. 2001. South Africa's national communicate under the United Nations Framework Convention on Climate Change. Republic of South Africa. Pretoria.

Department of Environmental Affairs. 2010. The National Climate Change Response Green Paper. South Africa.

Department of Rural Development and Land Reform. 2013. Climate Change Risk and Vulnerability Assessment for Rural Human Settlements, Spatial Planning and Facilitation Directorate. Republic of South Africa.

DeVilliers, D and Costello, J. 2006. Mkambathi and the WildCoast: South Africa and the Pondolands unique heritage. First Edition. Wilderness Safari. South Africa

Douglas, B. Kearney, M and Leatherman, S. 2000. Sea Level Rise: History and Consequences. Department of Geography, University of Maryland College Park. Maryland.

Dusgupta, S. Laplante, B. Meisner, C. Wheeler, D and J, Yan. 2009. Sea level rise and storm surges; A comparative analysis of impacts in developing Countries. The World Bank Development Research Group. Canada.

Eastern Cape Socio- Economic Consultative Council, 2012. Eastern Cape Socio Economic Atlas. South Africa.

Eastern Cape Socio Economic Consultative Council, 2014. Eastern Cape socio Economic Profile Report of the O.R. Tambo District. Eastern Cape. South Africa.

Emery, K and Aubrey, D.G, 1991. Global sea levels and Land levels: Climate and Sea level Change; Observations, Projections and Implications Proceedings, Climate Change Workshop. Norwich, Cambridge University Press, U.K.

Engelbrecht, C., Engelbrecht, F. & Dyson, L. 2013, High-resolution model-projected changes in mid-tropospheric closed-lows and extreme rainfall events over southern Africa, *International Journal of Climatology*. 33:1.173-187.

eThekwini Municipality. 2009. High Water Mark, Coastal Erosion and Hazard Delineation Model for the Durban Coastline; eThekwini Municipality: Durban, South Africa.

EuroSION. 2004. Sediment and space for sustainability results from the erosion study European Commission.

Gommes, R, Du Guerny, J and Nachtergaele, F and R. Brinkman, 1997. Sea level rise, population and agriculture. Food and Agriculture Organisation. Via delle Terme di Caracalla, Rome. Italy.

Gornitz, V. and Kanciruk, P. 1989. Assessment of global coastal hazards from sea-level rise. Proc. Sixth Symposium on Coastal and Ocean Management American Society of Civil Engineers. Charleston. 1345-1359.

Guastella, L.A and Rossouw, M. 2009. Coastal vulnerability; Are coastal storms increasing in frequency and intensity along the South African Coast? Proceedings of the 6<sup>TH</sup> International Multi purpose Reef Conference. Jeffereys Bay. South Africa.

Guetierrez, F and Guetierrez, M. 2016. Landforms of the Earth: An illustrated Guide. Earth Science Department. University of Zaragoza. Spain

Halloway, A and Roomaney, R. 2008. Weathering the storm: Participatory risk assessment for informal settlements. Cape Town. Peri-Peri Publications. Disaster Mitigations for sustainable livelihoods programme.

Hancock, B. Ockleford, E and Windridge, K. 2009. An Introduction to Qualitative Research. The National Institute for Health Research Design Service for East Midlands /Yorkshire and the Humber.

Hartman, D. 2016. Global Physics Climatology. Second Edition. Department of Atmosphere Sciences. University of Washington, Seattle. USA.

Hegerl, G and Zwiers, F, 2013. Understanding and Attributing Climate Change. The physical science basis contribution of working group 1 to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press.

Heinz Center. 2000. The hidden cost of coastal hazard implication for risk assessment and mitigation. A multi sector collaborative project of the John Heinz Center of Science.

Hewiston, B. 2006. Potential changes in Western Cape climate due to global warming. Presentation to Western Cape Government. CSAG University of Cape Town. South Africa.

Hox, J and Boeijs, H. 2005. Data Collection: Primary vs Secondary. Encyclopaedia of Social Measurement. Vol 1. Elsevier Inc.

Hulme, M, Barrow. E.M, Arnell, N and Harrison, P. Timothy. C, Johns and Thomas. E. Downing, 1997. Relative Impacts of Human induced climate change and Natural climate change variability. Climate Research Unit 397. 688-691.

Hunter, I. 2008. South African Weather Services, Pretoria. South Africa.

IDP. 2014-2015. King Sabata Dalindyebo Local Municipality: Eastern Cape. South Africa

IDP. 2015-2016. O.R. Tambo District Municipality: Draft IDP. Eastern Cape. South Africa

IPPC. 2007. Climate Change: The Physical Science basis Summary for Policy Makers, Contribution of Working Group 1 to the Fourth Assessment Report of Intergovernmental Panel on Climate Change. Cambridge University.

IPPC. 2011. Climate Change: Technical Summary impacts, adaptation and vulnerability. Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge.

Kates, R. W., W. C. Clark, R. Corell, J. M. Hall, C. C. Jaeger, I. Lowe, J. J. McCarthy, H. J. Schellnhuber, B. Bolin, N M. Dickson, S. Faucheux, G. C. Gallopín, A. Gröbler, B. Huntley, J. Jäger, N. S. Jodha, R. E. Kasperson, A. Mabogunje, P. Matson, H. Mooney, B. Moore III, T. O'Riordan, and U. Svedin. 2001. Sustainability science. Science 292:5517.641-642.

Langis, J. 2013: Adaptation measures for floods, storm surges and sea level rise. New Brunswick Environmental Trust Fund. Groupe Littoral et vie, Université de Moncton. New Brunswick. Brunswick.

Leone, F., Aste, J. P. and Leroi, E., 1996. Vulnerability assessment of elements exposed to mass movement: working towards a better risk perception. Senneset (ed1) Landslides. Balkema, Rotterdam.

Mackellar, N. New, M. and Jack, C. 2014. Observed and modelled trends in rainfall and temperature for South Africa. Vol 110. 7/8. South African Journal of South Africa.

Magaret, C and Mellisa A. Bradley, 2009. Data Collection Methods. Semi Structured Interviews and Focus Groups. The Training Manual. National Defence Research Institute. Santa Monica. RAND Corporation. TR 718-USG.

Marshall, M. 1998. Questionnaire Design; Asking Questions with a Purpose. University of Wisconsin- Extension.

Mather, A.A. 2006. International Report on the erosion along Eastmoor, Crescent, La Lucia during 2006. eThekweni Municipality. KwaZulu Natal. South Africa.

Mather. A, Garland G, and Stretch. 2009. South African sea levels, corrections, influences and trends. African Journal of Marine Sciences 31(2). 145-156.

McGranahan. G, Balk. D and Anderson. B, 2007. The rising tide; Assessing the Risk of climate change and human settlement in low elevation coastal zones. International Institute for Environmental and Development. Vol 19

Merriam, S. 2009. Qualitative Research. A guide to design and implementation. San Francisco, CA. John Wiley & Sons.

Michel. D and Pandya .A. 2010. Coastal Zones and Climate Change: Risk and Response. Henry L and Center S Publication. Colombo. Srilanka

Midgley, G. Chapman, R.A.; Hewitson, B.; Johnston, P.; de Wit, M.; Ziervogel, G.; Mukheibir, P.; van Niekerk, L. Tadross, M.; van Wilgen, B.W, 2007. A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape. Report to the Western Cape Government; Cape Town, South Africa, CRIR Report Number ENV-S-C-2005-073, Stellenbosch, South Africa.

National Disaster Management Centre. 2013. NDMC Annual Report 2010/ 2011 Pretoria. The Department of Cooperative Governance and Traditional Affairs. South Africa.

National Environmental Management: Integrated Coastal Management Act 24 of 2008. Government Gazette. Republic of South Africa.

Nicholls, R.J, Wong, P.P, Burket, J.O. 2007. Coastal Systems and low lying areas climate change: Impacts, Adaptation and Vulnerability. Contribution of Working Panel II to the 4<sup>th</sup> Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge Press University. 315-356.

Nunn, P.D. 2000. Sea level changes over the past 1000 years in the pacific. Journal of Coastal Research 14:1.23-30.

Park, C. 2001. The Environment: Principles and Applications. 2<sup>nd</sup> Edition. Taylor and Francis Group. USA. Canada.

Parry, M. 2007: Climate Change: Impacts, Adaptation and Vulnerability. Working Group II contribution to the fourth Assessment Report for the Intergovernmental Panel on Climate Change.

Pawlukiewicz, M.G, Gupta, P and Koelbel, C, 2007. Ten principles for coastal development. Washington. Urban Land Institute. USA.

Peck, Dallas, L and Williams, J, 2003. Sea level rise and its implications in coastal planning and management. US Geological Survey. Virginia. USA.

Rahmstorf, S. Cazenave, A. Church, A. Hansen, J. Keeling, R.F. Parker, D.E. Sommerville, R.C. 2007. Recent Climate Change Observation compared to projections.

Remler, D and Van Ryzin, G. 2011. Research Methods in Practice; Strategies for description and causation. Sage Publications. United States of America.

Rosenbua, P. 2011. Observational Studies. 2<sup>ND</sup> Edition. New York. Springer.

Rugg, G and Petre, M, 2007. A Gentle Guide to Research Methods. McGraw- Hill Education. United Kingdom.

Smith, A, Guestella, L.A, Bundy S.C, Mather, A.A. 2007. Combined marine storm and spring high tide erosion event along the Kwazulu Natal coast in March 2007. A preliminary assessment. Vol. 103.7/8. South African Journal of Science.

Statistics. 2013. South Africa. Statistics South Africa Library Cataloguing in publication (CIP) data. Pretoria. South Africa.

Stenseth, N.C, Hurrell, J.W, Chan, R.S and Lina, M. 2002. Ecological effects of climate fluctuations. *Science*. 207:297.1292-1296.

Stockholm Environment Institute - US Centre. 2008. UNEP Sourcebook: Integrating Adaptation to Climate Change into UNEP Programming. Kenya.

The Draft of the Eastern Cape Climate Change Response Strategy. 2001. South Africa.

The Long Term Adaptation Flagship Research Programme. 2013. Summary for policy makers. Department of Environmental Affairs. South Africa.

Theron, A. 2008. Climate Change, Sea Level Rise and the Southern African Coastal Zone: Analysis of potential coastal zone climate impacts and possible response options in the Southern African region. CSIR Conference. Pretoria. South Africa.

Theron, A.K, 2007. Analysis of potential coastal zone climate change impacts and possible response options in the South African region; Proceeding of the IPCC Workshop. South Africa.

Theron, A.K, Diedericks, G, Rossow, M, 2010. Potential impacts of climate change on the coastal zone in South African Risk and Vulnerabilities. Department of Science and Technology, Vol 978:620-4565.

Tsimplis, A.S, Meier, M.F, Baker, T.F. 2004. Sea level drop in the Mediterranean Sea. *Geophysical Research Letters*. 27:12.1731-1734.

UKCIP, 2003. Climate Change and Local Communities. A guide for local authorities in the United Kingdom. UK.

United Nations Environmental Programme. 2008. Disaster risk management for coastal tourism destinations responding to climate change. A practical guide to decision makers. Paris. France.

United Nations Environmental Programme /Nairobi Convention Secretariat. 2009. Transboundary Diagnostic Analysis of Land-based Sources and Activities Affecting the Western Indian Ocean Coastal and Marine Environment. Nairobi, Kenya: UNEP, 378P.



United Nations Environmental Programme. 2008. Climate Change and Tourism: Responding to Global Challenges. World Tourism Organisation and the United Nations Environment Programme. Madrid, Spain.

United Nations Development Programme. 2010. Mapping Climate Change Vulnerability and Impact Scenarios. A guide book for sub national planners. Bureau for development policy. UNDP, New York

Watson R. Zinyowera M, Moss R, Dokker. D. 1999. The Regional Impacts of Climate Change: An Assessment of Vulnerability. A special report of IPCC Working Group II. Cambridge University Press. Cambridge.

Watson R. 2001. Climate Change. Synthesis Report: Contribution of Working Group I II III to the third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge. United Kingdom.

Whitney, C. K., N. J. Bennett, N. C. Ban, E. H. Allison, D. Armitage, J. L. Blythe, J. M. Burt, W. Cheung, E. M. Finkbeiner, M. Kaplan-Hallam, I. Perry, N. J. Turner, and L. Yumagulova. 2017. Adaptive capacity: from assessment to action in coastal social ecological systems. *Ecology and Society*, 22:2.22.

World Glacier Monitoring Service. 2007. Glacier mass balance bulletin: Bulletin no. 9 (2004-2005). Technical report, World Glacier Monitoring Service, Zurich, Switzerland.

World Development Report. 2010. Development and Climate Change. The international Bank for Reconstruction and Development. The World Bank. Washington DC 20433.

World Development Report. 2010. Development and Climate Change. The International Bank for Reconstruction and development. The World Bank, Washington DC. 20433

Wright C.I, McMillan I.K, Mason T.R. 1990. Foraminifera and sedimentation patterns in St. Lucia Estuary mouth, Zululand, South Africa. *South African Journal of Geology*, Vol 93, Issue 4. 592–601.

Wright, R. 2005. Environmental science towards a sustainable future. 9<sup>th</sup> Edition. Pearson Education. United States of America

Yorkshire Futures. 2002. Warming up the region. Yorkshire and Humber Climate Change scoping study.

Ziervogel, G. New, M. Van Garden, E. Midgley, G. Taylor, A. Hamann, R. Stuart-Hill, S. Meyers, J. and Warburton, M. 2014. Climate Change impacts and Adaptation in South Africa. WIRE's Climate Change 5: 605-620/ wcc295.

Zschau. J and Kuppers. A. 2003. Early Warning Synthesis for National Disaster Reduction. Geofouchugs Zentrum Postdam. Telegrafenberg. Germany

## **APPENDIX A**

### **Survey questionnaire to be administered to local government officials.**

This questionnaire forms part of the data required for a Masters Degree in the Department of Biological and Environmental Sciences, Walter Sisulu University. The research is based on a study that examines the vulnerabilities of coastal settlements to the impact of climate change. The information received will be very helpful therefore your cooperation will be highly appreciated.

**NB: The information provided in this questionnaire is solely for the purposes of this academic research and will not be made available to any organization, or institution thereof other than the University funding this research. Full anonymity will be maintained. You therefore reserve a right to withdraw from the study at any time. However I am pleading with you to sustain your participation until the end because as noted earlier your input in the study is crucial.**

**(MARK WITH X WHERE APPLICABLE)**

DATE..... TIME.....

### **Section A**






#### **Demographics**

1. Gender of respondent







a) Male

b) Female

2. Age of respondent

- a) <25 years 
- b) 26-35 years 
- c) 36-45 years 
- d) 46-55 years 
- e) 56-65 years 

3. Highest educational level

- a) No Formal Education 
- b) Primary School 
- c) High School 
- d) Diploma 
- e) Degree 
- f) Post graduate degree 

4. How would you typically rate the current state of climate change?

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5. What would you say are the major climate conditions and weather events affecting our coastal environments?

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6. Which areas would you rate the most vulnerable? Please elaborate

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7. What types of approaches are being used in adaptation planning and implementation?

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8. What are the main challenges faced in controlling the impacts of climate change on coastal settlements?

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9. What is distinctive about rural coastal areas and its vulnerabilities and adaptation measures?

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10. How can coastal communities plan and adapt to the impacts of climate change?

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11. What coastal protection measures have been put in place to ensure the protection of coastal properties and how can communities protect themselves from extreme weather events?

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12. Is there any additional long term development and infrastructure plans put in place to protect coastal communities from these impacts?

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13. Coastal flooding is a major issue for our coastal communities. Can you outline the processes used to protect the coastline from flooding?

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14. How is climate change placed into consideration in accordance with coastal zone planning?

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15. What basic options would you recommend to coastal people to reduce their risk to climate change?

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16. Who is responsible for alerting the general public about an actual or possible emergency and how are these emergencies carried out to the general public?

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17. Has the general public been educated about the meaning of emergencies and responding techniques?

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18. Please outline the general procedures followed by the local risk management team in protecting and mitigating as well as dealing with the impacts after a coastal disaster

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Thank You for your time. Your input is highly appreciated.

For further enquiries please don't hesitate to call at 0832719617 or email at [athinaashlevanderbyl@yahoo.com](mailto:athinaashlevanderbyl@yahoo.com) or alternatively you can contact my supervisors:

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Mr A. Bango at 083 518 0564 or email at [abango@wsu.ac.za](mailto:abango@wsu.ac.za)

**APPENDIX B**

**Survey questionnaire to be administered to resort owners in Coffee-Bay and Port St Johns**

This questionnaire forms part of the data required for a Master’s Degree in the Department of Biological and Environmental Sciences, Walter Sisulu University. The research is based on a study that examines the vulnerabilities of coastal settlements to the impact of climate change. The information received will be very helpful therefore your cooperation will be highly appreciated.

**NB: The information provided in this questionnaire is solely for the purposes of this academic research and will not be made available to any organization, or institution thereof other than the University funding this research. Full anonymity will be maintained. You therefore reserve a right to withdraw from the study at any time. However, I am pleading with you to sustain your participation until the end because as noted earlier your input in the study is crucial.**

Questionnaires to coastal property owners along the Wild Coast

**(MARK WITH X WHERE APPLICABLE)**

DATE..... TIME.....

**Section A**

1. What type of settlement do you represent?

a) Home

b) Resort

- c) Hotel
- d) Other

2. How many years has the settlement been on the property?

- a) 0- 5 years
- b) 6-10 years
- c) 11-15 years
- d) 16-20 years
- e) 21 – More  please specify.....

3. How well would you say you understand global environmental issues?

- a) Very well
- b) Fairly well
- c) Not very well
- d) Not at all

4. How well would you say you understand climate change?

- a) Very well
- b) Fairly well
- c) Not very well
- d) Not at all

5. Do you think that human activity is contributing to these global issues?

- a) Significantly contributed by humans
- b) Moderately contributed by humans
- c) Not by humans but rather natural causes
- d) Not sure

6. How do you think the conditions resulting from climate change will be for the next generation?

- a) Remain the same
- b) Worsen
- c) Better
- d) Not sure

7. According to your understanding, how would you rate the following issues with regard to the impact on your property ( 1 is the lowest impact and 5 the highest impact)

- a) Sea level rise
- b) Storm surges
- c) Floods
- d) Coastal erosion

SECTION B

8. How important do you think climate change is to you? Please elaborate.....  
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9. Are you aware of the vulnerabilities of climate change as well as its risk on coastal environments?

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10. Were you aware of the vulnerabilities and impacts of climate change upon purchasing the property? Please elaborate?

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11. Do you monitor climate conditions that could possibly affect your property?  
How do you achieve this?

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12. Have you been affected by the impacts of climate change or any other weather extremities? Please indicate and discuss

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13. If yes to Question 12, what was the direct impact to your property? Please specify and elaborate?

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14. Any other additional impacts to the property?

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15. When would you say was the last significant disaster event and what lessons would you say you learnt regarding the vulnerability of your property and preparedness?

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16. Are you insured for the damage or loss of property caused by the impacts of extreme weather conditions?

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17. How do such events affect your insurance or financial services?

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18. As the owner of the property, have you done anything to reduce the impacts of weather events on your property? Please elaborate.....

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19. Who do you think should be responsible for mitigating climate change and its impacts? Please explain.....

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20. How would you rate the level of accountability and responsibility of the local risk management team? Please explain

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Thank you for participating

Your input is highly appreciated.

For further enquiries please don't hesitate to call at 060 716 4403 or email at [athinaashlevanderbyl@yahoo.com](mailto:athinaashlevanderbyl@yahoo.com) or alternatively you can contact my supervisors:

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