Development of a Climate Change Response Strategy for the Ugu District Municipality

Reference: 112297
Prepared for: Ugu DM
Revision: 3
15 November 2016

Leading. Vibrant. Global.
www.aurecongroup.com

Document Control Record

Document prepared by:
Aurecon South Africa (Pty) Ltd
1977/003711/07
3rd Floor
Park Row Building
4-10 School Road
Pinetown
3610
PO Box 932
Pinetown
3600
South Africa

T +27 31 714 2500
F +27 31 702 0287
E eThekwini@aurecongroup.com
W aurecongroup.com

A person using Aurecon documents or data accepts the risk of:

a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
b) Using the documents or data for any purpose not agreed to in writing by Aurecon.

Development of a Climate Change Response Strategy for the Ugu District Municipality

Date | 15 November 2016
Reference | 112297
Revision | 3

Aurecon South Africa (Pty) Ltd
1977/003711/07
3rd Floor
Park Row Building
4-10 School Road
Pinetown
3610
PO Box 932
Pinetown
3600
South Africa
T +27 31 714 2500
F +27 31 702 0287
E eThekwini@aurecongroup.com
W aurecongroup.com

Contents

Index of Figures

Index of Tables

Executive Summary

To be completed once final draft is approved…

Concepts and Definitions

Term	Definition
Adaptation	The process of adjustment to actual or expected climate change and its effects, in order to moderate negative impacts or exploit potential opportunities.
Baseline/observation data	The simulated climate model output constrained by known observational satellite and station data.
Capacity	The combination of all strengths, attributes and resources available within a community, society or organisation that can be used to achieve agreed goals.
Climate	Defined in a narrow sense as the average weather experienced over a period of time.
Climate Change	Climate Change refers to the long term shift in weather patterns. It may involve changes in average weather patterns or in the frequency and intensity of events. Climate change can be caused by natural processes or human causes.
Climate Variability	Climate variability refers to short term variations in the average state of climate variables, without influencing the long term averages.
Dry spell duration	The number of consecutive days not classified a rainfall day.
Extreme rainfall day	Twenty four hours during which 15mm or more of precipitation fell.
Extreme temperature day	A day where the mean day time temperature exceeded/will exceed 35°C
GCM	Global Circulation Model: simulates the global climate under particular climate scenarios in order to assess the likely future global climate status.
Hazard	A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.
Heat wave event	Five consecutive days with daytime temperatures higher than the observed monthly climatological mean.
Impact	Impacts refer to the effects on human and natural systems. In this document it refers primarily to the effects of extreme weather and climate events and climate change on human and natural systems.
Mitigation (Climate Change)	A human intervention to reduce the sources of greenhouse gases.
Rainfall/precipitation day	Twenty four hours during which 0.2mm (cumulative) of precipitation fell.
RCM	Regional Climate Model: simulates a particular regional climate in higher resolution than a GCM and is able to give more localised projected climate information.
Resilience	The capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past negative impacts for better future protection and to improve risk reduction measures.
Response	Climate Change Response encompasses a two-pronged approach addressing both climate change mitigation and adaptation.
Risk	The combination of the probability of an event occurring and its negative consequences.
Vulnerability/Exposure	The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Conditions of vulnerability and susceptibility

Term	Definition
	to the impact of climate change impacts are determined by physical, social, economic and environmental factors or processes.
Informal Settlement	Groups of unauthorised houses that do not comply with building standards.
Rural areas	Undeveloped land with a low population density.

Acronyms and abbreviations

Abbreviation	Meaning
CoGTA	Department of Cooperative Governance and Traditional Affairs
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
ENSO	El Niño-Southern Oscillation
EPWP	Expanded Public Works Programme
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IDP	Integrated development plan
IPCC	Intergovernmental Panel on Climate Change
LTAS	Long Term Adaptation Scenarios
M&E	Monitoring and evaluation
NAS	National adaptation strategy
NGO	Non-governmental organisation
RCP	Representative concentration pathway
R&D	Research and development
SANBI	South African National Biodiversity Institute
SAWS	South African Weather Service
UNFCCC	United Nations Framework Convention on Climate Change
WMA	Water management area

1 Problem Statement

Main objective of the study was to compile a comprehensive survey in order to assess the vulnerability of the district's sectors to climate change. This processes entailed a combination of desktop research, stakeholder engagement and targeted fieldwork, if required. The vulnerability assessment then formed the basis for the development of a climate change response strategy and implementation framework for the Ugu District to facilitate the formalizing of programmes and projects that will focus on adaptation and mitigation. The project seeks to interpret and assess various data sources and analyses with the aim of presenting the complex and interrelated challenges posed through projected climate changes in a locally applicable and practical. This is undertaken in a manner such that the strategies, decisions and projects are drawn home to the local context of Ugu District Municipality allowing increased resilience and exposure to the climate hazards and for the benefit of the district population.

There is consensus that climate change in anthropogenic in cause and that it has already, and will, result in increased day and night time temperatures and more variable and uncharacteristic rainfall patterns globally.

In the context of South Africa, the varied environments will result in areas experiencing differing impacts as a result of this climate change. There are likely to be both "winners" and "losers" from climatic changes[1] with some areas potentially benefiting from more favourable rainfall regimes and more temperate climates, while others might be rainfall deprived and experience enhanced heatwave activity. In South Africa the Long Term Adaptation Scenarios (LTAS) flagship program confirmed these trends and outlined four possible climate change scenarios for different areas within South Africa.

1. Warmer (<4°C above 1961-2000) and wetter with greater frequency of extreme rainfall events.

2. Warmer (<4°C above 1961-2000) and drier, with an increase in the frequency of drought events and somewhat greater frequency of extreme rainfall events.

3. Hotter (>4°C above 1961-2000) and wetter with substantially greater frequency of extreme rainfall events.

4. Hotter (>4°C above 1961-2000) and drier, with a substantial increase in the frequency of drought events and greater frequency of extreme rainfall events.

Each of the six hydrological zones in South Africa will, to some degree, adhere to these scenarios and the day to day meteorology will be manifest through these climate changes. The changes already experienced in South Africa pose a significant challenge to the long term socio-economic well-being of

[1] Schulze. R.E., Approaches towards practical adaptive management options for selected water-related sectors in South Africa in a context of climate change, ISSN 1816-7950, Water Research Commission, Vol. 37 No. 5, Kempton Park, September 2011.

South Africa in general and Ugu District Municipality and its residents in particular. Climate change threatens the resources and systems which support human life including water resources, human health, food security and ecosystem services. Climate change has the potential to impact every aspect of our day-to-day lives:

- Ecosystems may suffer biodiversity and habitat loss from to retreat of natural vegetation forced by temperature threshold sensitivity. The enhanced variability of the rainfall will disadvantage present sensitive rain fed vegetation and ecosystems and advantage insensitive vegetation;

- In the presence of higher temperatures and less reliable rainfall, the agricultural sector will be forced to adapt practices, rely heavily on seasonal forecasts or consider crops alternative;

- Warmer night-time temperatures may allow for increased mosquito activity further south and over more of the year then currently observed. This will impact human health through the spread of potential disease vectors;

- Both the increased temperature and the variability of rainfall intensity will impact the durability and maintenance schedule of current urban systems and infrastructure through the enhanced thermal expansion of infrastructure, and heightened overland flow and erosion rates. Approaches to development must consider these influences;

- The greening of the economy, focusing on the fair and sustained usage of resources, will begin to override, and over time supersede traditional business models unaligned with sustainable development goals, particularly in the context of further climate changes; and

- Climate change, if adaption measures are not undertaken, can render areas unsuitable for sustained habitation or agriculture. In such cases migration or adaptation of livelihoods is forced. The populous may favour industry less sensitive to climate changes and voluntarily migrate to economic centres and thereby exacerbating existing urbanization complications.

Ugu District is mandated under the Constitution of the Republic of South Africa (1996) Section 24 (a) to guarantee everyone an environment that is not harmful to his or her health or well-being. The subsequent clause advocates for sustainable development in which social and economic development is pursued for the present generation without compromising opportunities for future generation. Further the National Development Plan states that a climate change response is imperative to strengthening the nations' resilience and requires the identifying and putting into effect appropriate policies and measures to be climate adaptive.

The Ugu District has recognized the crucial role it plays in responding to climate changes by building resilience and adaptive capacity, particularly with regard to human settlement and urban development planning in the short, mid and long term. In order to suitably address the challenges posed by climate change in Ugu District, the study of the likely changes to the climate to be experienced, the assessment of the risks and vulnerabilities in each sectors and the development of a robust, no-regrets strategy must be undertaken. In doing so Ugu District seeks to fulfil its objectives of sustainable and equitable service provision, enabling socio-economic development and providing a safe and healthy environment for all.

1.1 Climate change

Studying the likely climate changes refers to assessing the long term climatic condition variation from the normal (observed) climate patterns and establishing an altered baseline from which natural (seasonal, annual and decadal) variability acts.

Climate change is driven by the introduction of long residence greenhouse gases into the atmosphere at heightened volumes through unchecked industrial development. While greenhouse gases are naturally present and required in the atmosphere, the excessive utilization of fossil fuels through

industry, vehicle emissions, landfill sites and farming, escalates the atmospheric levels of carbon dioxide and methane, in particular.

Global temperatures are increasing and will continue to do so, and that these can largely be attributed to human impacts[2]. There is still uncertainty regarding the potential for future impacts on spatial precipitation changes. Some areas of the global likely to experience increased precipitation with changes in the likely onset, duration and intensity of monsoons and large rain events as well as frequency of rainfall events leads to heightened flood risk. While other areas are projected to receive reduced average annual precipitation and may experience increased dry spell duration with droughts becoming more prevalent. It is however agreed that the in general, precipitation is likely to become more variable with an increase in the occurrence of extreme events contributing to a heightened potential risk of both floods as well as droughts. Other impacts include the decline of global ice and snow cover and the subsequently reduced surface albedo enhancing temperature increase further. The increase in fresh water moving into the oceans compounded with rising ocean temperatures is weakening the thermohaline circulation which drives ocean climatology. The thermal expansion of the ocean also results in sea level rise and risk of coastal inundation. The combined effects of these impacts will serve to impact the climatic risk and vulnerability profiles between different regions over time.

1.2 Climate sensitivity, impacts and exposure

The climatic exposure of an area or sector is the degree to which day to day systems and functionality are susceptible to the impacts associated with changes in the persistent weather regime and the inability to adapt/cope with these changes over time. Assessing the risks/impacts and sensitivities of sectors and areas within the Ugu District will allow for improved processes for responding, adapting to and mitigating against (where possible), the effects of climate change will be necessary not only to protect against adverse consequences, but also to enable societies to take advantage of any potential benefits that may result.

Exposure, vulnerability and the inability to cope can be increased due to anomalous seasonality, frequency, intensity, spatial extent and duration of weather and climate related extremes. These variations have been noted in the observed record of the Ugu District, examples would be the recent heat waves present in the area during October to November 2015. The observed and projected increase in the magnitude and probability of more severe weather events is measured against the vulnerability of an area to determine the potential risk associated climate impacts. A lack of resilience and capacity (both institutional and personal) to adapt will intensify the pressure being placed on human and natural systems increasing their susceptibility to the adverse effects of climate change.

1.3 Strategy development

The aim of developing a climate change response strategy is to provide strategic recommendations for how the Ugu District can address the risk of climate change and enable the Ugu District to initiate administrative functions, instruments and processes required to influence mitigating and adaptive behaviour, progressing towards more sustainable livelihoods and improved community resilience improving overall well-being irrespective of the actual pace and severity of climate change within the expected climate change envelope.

In alignment with the National Climate Change Response Policy, the Ugu DM Climate Change Response Strategy takes a dual approach to climate change response, encompassing adaptation and mitigation.

- **Adaptation** to climate change refers to adjustments in human and natural systems in response to actual or expected climatic variations, with a view to moderating harm or exploiting beneficial

[2] Intergovernmental Panel on Climate Change, 2013. Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report, Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

opportunities[3]. It addresses the reduction of climate vulnerability and enhancement the adaptive capacity in terms of the local communities, economy, ecosystems and infrastructure.

- **Mitigation** refers to efforts to reduce/prevent the emission of greenhouse gases (GHGs) and/or facilitating their removal from the atmosphere. As such the Ugu DM will be contributing to national efforts in reducing GHG and developing a low carbon economy in support of livelihood sustainability.

The key focus area of the Strategy in terms of Response are:

- Water security and efficiency;
- Climate resilient and low carbon development:
    - Infrastructure
    - Transport
    - Settlements
- Energy efficiency and demand side management;
- Biodiversity and ecosystem management;
- Food security (Agriculture);
- Public health;
- Disaster management; and
- Build climate response capacity through improved coordination, research and institutional and public awareness.

Addressing climate change will require a shift away from business as usual, with specific reference to production and consumption patterns in priority sectors such as water, energy and agriculture. Ugu District will be required to play an active role in shifting perceptions and facilitating the implementation of both mitigation and adaptation strategies if they are to properly fulfil service delivery needs and to provide long term peace, stability and economic development. Taking action now to safeguard against inevitable climate changes will limit future losses and contribute to building a resilient Ugu District and support sustainable development goals.

Climate changes are not constrained by the timeframe of political tenure and as such, an effective climate change response requires visionary long term planning and decision-making for reaping benefits in time horizons beyond normal administrative timeframes. If managed correctly, climate change can be transformed into an opportunity for governance innovation within the Ugu District. Acting in the sphere of an uncertain climate future, an appropriate climate change response will likely become a normal component of what is considered as “good governance”[4].

1.4 Policy Context: Climate Change Response

The legislative provision for promoting adaptive sustainable climate change strategies is encapsulated enshrined in the Constitution of the Republic of South Africa (1996) from which all other legislation in

[3] IPCC.2007.

[4] Du Plessis and Kotze. 2013. The role of local government in South Africa’s climate change effort. Unpublished Conference paper delivered at the UNITAR Second Global Conference on Environmental Governance and Democracy strengthening institutions to address climate change and advance Green economy.

the country is derived. Section 24 (a), guarantees everyone an environment that is not harmful to his or her health or well-being. The subsequent clause advocates for sustainable development in which social and economic development is pursued for the present generation without compromising opportunities for future generation. Furthermore, Section 152 (1) (d) implores local government authorities to promote a safe and healthy environment (Constitution of the Republic of South Africa 1996).

South Africa's climate change policy firework has been developed in alignment with the UNFCCC and culminated in the compilation National Climate Change Response Policy (NCCRP) (2011) as the primary policy document guiding climate change response in South Africa. The NCCRP imposes the mainstreaming of climate change and alignment of policies, strategies, legislation, regulations and plans to the NCCRP. The Policy declares two primary objectives[5]:

1. Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity;
2. Make a fair contribution to the global efforts to stabilise GHG concentrations in the atmosphere at a level that avoids dangerous anthropogenic interferences with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

Accordingly there is a direct link with development planning which is reiterated in the National Development Plan's endorsement of climate change response as imperative to strengthening the nations' resilience and requires local, provincial and national governments to embrace climate adaptation by identifying and putting into effect appropriate policies and measures (NDP 2011: 180).

The Disaster Management Amendment Act No. 16 of 2015 as one of the first pieces of legislation to explicitly address climate change response, mandates all levels of government prepare a disaster management plan which among other requirements stipulates the assessment of expected climate changes, impacts and risks.

A number of relevant strategies, plans and frameworks from the international arena down to local government have been considered in the development of the Ugu District Climate Change Response Strategy. The most relevant of are presented in a tiered list below. The scope of this report does not allow each of these documents to be unpacked in detail, however they are in the public domain and easily accessible. Their relevance in terms of climate change response is briefly discussed in the following sections and addressed in greater detail in Chapter 5 and 6 of this report.

International

Although not having any direct implications for local level climate change response, South Africa's approach is influenced and shaped by the prevailing international policy context. Some of the key international measures and policies includes:

- UNFCCC;
- Kyoto Protocol – ratified emission targets for developed countries;
- International Carbon Action Partnership;
- Untended Nations Sustainable Development Goals;
- Sendai Framework for Disaster Risk Reduction (2015);
- The Cancún Agreements (2010) - finance, technology and capacity-building support package to help developing nations adapt to climate change and adopt sustainable paths to low-emission economies;
- Durban Platform for Enhanced Action (2011) –provided a roadmap towards a new legal framework by 2015 and agreement on the design and governance arrangements for the new Green Climate Fund; and

[5] DEA. 2011. National Climate Change Response Policy.

- The Paris Agreement (2016).

South African

National Government's approach to climate change response has almost exclusively been dealt with through policies, strategies and regulations rather than legislation. Carbon Emissions Motor Vehicles Tax and Disaster Management Amendment Act serves as the only exceptions to date.

General

- Constitution of the Republic of South Africa (Act 108 of 1996);

Climate Change

- The National Climate Change Response Policy (2011);
- Long Term Adaptation Scenarios (LTAS) (2014);
- Long Term Mitigation Scenarios (LTMS) (2014);
- South Africa National Carbon Sink Assessment (2015);
- Green Economy Accord, Economic Development Department (2011);
- Draft National Adaptation Strategy.

Development Planning

- Regulations for the establishment of a Designated National Authority for the Clean Development Mechanism (2005)
- The National Development Plan 2030 (2012);
- National Sustainable Development Framework (2008);
- The National Strategy for Sustainable Development and Action Plan (NSSD1) (2011 – 2014);
- Integrated Resource Plan;
- Industrial Policy Action Plan: 2012/2013 - 2014/15;
- Dept. of Rural Dev. and Land Reform, Strategic Plan 2011-2014 (amended 2013);
- Spatial Planning and Land Use Management Act

Environmental

- National Environmental Management Act (NEMA) (Act 107 of 1998) and amendment Act (Act 62 of 2008);
- National Environmental Management: Air Quality Act (Act 39 of 2004);
- National Environmental Management: Air Quality Act (39/2004): List of activities which result in emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage (2010)
- National Environmental Management: Air Quality Act (39/2004): Atmospheric Emission License Regulations (2010)
- Integrated Coastal Management Act (2008);
- National Environmental Management: Protected Areas Act, 2003;
- National Environmental Management: Biodiversity Act, 2004;

Agriculture

- Strategic Plan 2015-2019, for the Dept. of Agriculture, Forestry and Fisheries;

- Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries;
- Climate Change Sector Plan for Agriculture, Forestry and Fisheries (2013)
- Conservation of Agricultural Resources Act, 1983;
- Strategic Plan for Smallholder Producers;
- Food and Nutrition Security Policy (2014)

Energy

- Renewable Energy White Paper (2003)
- Integrated Energy Plan;
- National Energy Efficiency Strategy (NEES)
- National Energy Efficiency Action Plan (NEEAP);
- National Energy Act (Act No. 34 of 2008);
- Electricity Regulation Act (Act No. 4 of 2006), Second Amendment (2011);
- Amendment to the Electricity Regulations on new generation capacity (18 August 2015)

Water

- National Water Act (Act 36 of 1998);
- National Water Resource Strategy;
- National Climate Change Strategy for Water Resources :
- Water for Growth and Development Framework (2009);
- Working for Water.

Disaster Management

- Disaster Management Act (Act 57 of 2002);
- Disaster Management Amendment (Act 16 of 2015).

Transport

- Carbon Emissions Motor Vehicles Tax (2010);
- Draft National Green Transport Strategy (2016);
- Department of Transport: Strategic Plan 2015/16 - 2019/20.

KwaZulu Natal Province

- Provincial Climate Change Vulnerability Assessment
- KZN Provincial Growth and Development Strategy
- KZN Green Economy Strategy;
- Durban Adaptation Charter;
- Department of Agriculture and Rural Development, Strategic Plan 2015-2022;
- Let's Respond Toolkit.

Ugu District Municipality

- Integrated Development Plan;
- Ugu District Growth and Development Strategy;

- Air Quality Management Plan;
- Environmental Management Framework and Plan;
- Coastal Management Programme;
- Disaster Management Plan;
- Spatial Development Framework; and
- Ugu Water Master Plan (currently being developed); and
- Let's Respond Toolkit.

1.4.1 International Level

The latest assessment of climate change risks and exposure at a global level are contained in the International Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2015). Addressing the climate change problem will require a concerted global effort. Although there are various other role-players, the primary international body dedicated to addressing and coordinating climate change adaptation is the United Nations Framework Convention on Climate Change (UNFCCC).

In addition, areas of international law and practice are currently being applied to address climate change adaptation although the applications are complex and not yet adequately understood.

It is suggested that closer integration and mainstreaming of climate change adaptation into international development is required to achieve greater efficiency in the application of available resources and capacity[6]. To date sufficient coordination and cooperation has been lacking which leads to fragmented implementation of international level climate change adaptation and a disproportionate focus on reduction of greenhouse gases rather than adaptation.

The emphasis, as is evidenced at the recently completed Conference of Parties (COP21) in Paris (December 2015), addressing the lack of resilience and poor development planning to which the most vulnerable counties are subject. Geographically, the emphasis will be on populations located in are low lying coastal areas and areas expected experience significant rainfall changes, particularly droughts and floods. The overall objective is to produce tangible results, in terms of applicable research and development and new procedural tools to reduce exposure to climate change through the provision of finance, knowledge and operational partnerships.

This and other key outcomes of COP 21 has been captured in the Paris Agreement on climate change. The Paris Agreement has been adopted on 12 December 2015 and is a treaty under international law, but only certain provisions are legally binding. The Agreement is a comprehensive framework for addressing climate change on an international level. The key outcomes and commitments include:

- Reaffirm the goal of limiting global temperature increase well below 2 degrees Celsius, while urging efforts to limit the increase to 1.5 degrees;
- Establish binding commitments by all parties to make "nationally determined contributions" (NDCs), and to pursue domestic measures aimed at achieving them;
- Commit all countries to report regularly on their emissions and "progress made in implementing and achieving" their NDCs, and to undergo international review;
- Commit all countries to submit new NDCs every five years, with the clear expectation that they will "represent a progression" beyond previous ones;
- Reaffirm the binding obligations of developed countries under the UNFCCC to support the efforts of developing countries, while for the first time encouraging voluntary contributions by developing countries too;
- Extend the current goal of mobilizing $100 billion a year in support by 2020 through 2025, with a new, higher goal to be set for the period after 2025;

[6] IPCC. 2014. Summary for Policy Makers. In: Climate Change 2014: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

- Extend a mechanism to address “loss and damage” resulting from climate change, which explicitly will not “involve or provide a basis for any liability or compensation;”
- Require parties engaging in international emissions trading to avoid “double counting;” and
- Call for a new mechanism, similar to the Clean Development Mechanism under the Kyoto Protocol, enabling emission reductions in one country to be counted toward another country’s NDC.

The Paris Agreement is regarded as significant landmark in the development of the international climate change regime under the UNFCCC. However a significant portion of the operational details of the new framework are only to be established in future COP’s.

Other highlights from COP21 include:

- The International Solar Alliance - enables developing countries with rich solar resources to better utilize the abundant, free natural resource.

- Least Developed Countries Fund - to support climate adaptation in countries that can’t afford it.

- Phasing out of subsidies for fossil fuel usages through promoting policy transparency, reform and targeted support for the poorest countries using fossil fuel.

- Multinational think-tank tasked with researching the large scale reduction of greenhouse gas emissions in developing countries.

- Transformative Carbon Asset Facility - will assist countries implement carbon cutting initiatives.

- Mission Innovation - launched to “dramatically accelerate public and private global clean energy innovation”[7]

- A recommitment to the halting/reversing deforestation and massively increasing forest restoration while promoting equitable rural economic development.

South Africa’s Indented Nationally Determined Communication[8] (INDC) submitted priority to the UNFCCC priori to COP 21outlines the national commitment to addressing the challenge of climate change is based on science and equity. The INDC presents a national response which considers both the overarching development needs and climate change imperatives. The need to balance the two priorities is an important issues across the developing world, and acknowledge in the Paris Agreement.

1.4.2 National Level

The National Government has implemented a variety of climate change related policies, strategies and plans. The Department of Environment Affairs (DEA) is designated to lead the country’s climate change agenda with responding and adapting to climate change as one of several strategic national objectives, with the NCCRP serving as the primary framework for the national response.

The acknowledges climate change as one of the country’s greatest threats to sustainable development and builds on the legally binding obligations contained in the UNFCCC and Kyoto Protocol as well as to a number of outcomes agreed to at COP15 in Copenhagen in 2009. The Climate Change White Paper outlines the National Government’s climate change response visions and outlines the requirements for achieving effective climate change adaption and mitigation in terms of resources, coordination, finance and monitoring requirements which can be used to drive implementation. It mandates local government

[7] COP21: UN chief launches initiative to build climate resilience of world’s most vulnerable countries - http://www.un.org/

[8] DEA. 2015. Discussion Document: South Africa’s intended Nationally Determined Contribution (INDC): 1 August 2015

to develop a climate change response strategy to tangibly implement the national policy of building climate resilience on a local scale. In addition the White Paper has set in motion the development of sectoral climate change adaptation plans with the ultimate goal of integrating climate change adaptation with sustainable development policies.

Legislative motivation for the implementation of climate resilience and no-regret practices into sustainable development initiatives can be derived from the White Paper. Furthermore the White Paper sets the framework from which priority flagship climate change response programmes derive authority. These programmes are discussed in greater detail in the National Climate Change Response White Paper and include:

- The Climate Change Response Public Works Flagship Programme;
- The Renewable Energy Flagship Programme;
- The Energy Efficiency and Energy Demand Management Flagship Programme;
- The Transport Flagship Programme;
- The Waste Management Flagship Programme;
- The Carbon Capture and Sequestration Flagship Programme; and
- The Adaptation Research Flagship Programme.

A set of structures and mechanisms have been set up at national level to assist with coordination on climate change issues:

- The Inter-Ministerial Committee on Climate Change (IMCCC) – Executive level committee to ensure the coordination and alignment of climate change actions with national policies and legislation;
- Forum of South African Directors-General (FOSAD) – responsible for guiding climate change response actions on a cluster basis;
- Intergovernmental Committee on Climate Change (IGCCC) – responsible for facilitating the sharing of information, consultation, agreement, assistance and support among the spheres of government with respect to climate change and government's response to climate change.

In a development context Climate change is addressed in the National Development Plan (NDP) acknowledging South Africa's vulnerability and identifying climate change response as key to achieving national objectives. From a climate change perspective the NDP emphasizes the implementation of mitigation measures and the need for a greener economy and highlights agriculture as a priority area for focusing adaptation efforts.

Climate change response and sustainable development are interrelated concepts. Accordingly it is important to acknowledge the National Sustainable Development Framework and National Strategy for Sustainable Development and its strategic objectives as local governments begin to formulate their climate change responses. These two documents are key in mobilizing an integrated and sustainable approach to managing national resources and identifies climate change response as a key priority.

1.4.2.1 Agriculture

The Department of Agriculture, Forestry and Fisheries is the custodian of the regulatory framework governing the agricultural sector is the responsibility, while implementation is a national and provincial competency.

The national agricultural policy was approved in 1996 with the mission to 'Ensure equitable access to agriculture and promote the contribution of agriculture to the development of all communities, society at large and the national economy, in order to enhance income, food security, employment and quality of life in a sustainable manner'[9].

[9] Department of Agriculture. 1995. White Paper on Agriculture. Pretoria, South Africa.

The was followed by the Strategic Plan for South African Agriculture (2001), which unfortunately failed to deliver on the goals set out in the document. This failure was attributed to a combination of institutional capacity and financial constraints. The Strategic Plan was succeeded by the DAFF Integrated Growth and Development Plan (IGDP) (2012)[10].

The IDGP is aimed at achieving sustainable growth and recognises the threat climate change poses to food security and poverty reduction. The IGDP recognises both the risk and potential opportunities associated with climate change and the optimal function of ecosystem services putting forward response strategies geared towards sustainable agriculture.

The department's current strategic plan for the period of 2015/16 to 2019/20[11] captures the ideals of the IGDP in its delivery targets and implementation framework. In keeping with the Strategic Plan and IGDP's recognition of climate change risk DAFF has developed a Climate Change Sector Plan for Agriculture which was release for public comment in June 2015. The plan addresses the institutional arrangements, vulnerability assessments, and responses required for climate resilience in the agricultural sector.

Another important instrument in the agricultural policy context in the National Policy on Food and Nutrition Security for the Republic of South Africa (2014) and the accompanying draft implantation plan. The policy states that food security will require well-managed inter-sectoral co-ordination, and the genuine integration of existing policies and programmes in health, education, and environmental protection, as well as in agrarian reform and agricultural development. It puts forward five pillars to constitute the foundations of food and nutrition security in South Africa. They include:

- The need for improved nutritional safety nets by state, private and non-governmental actors;
- Better nutritional education;
- Increased investment in agricultural, particularly in rural areas, to improve the efficiency of food storage and distribution networks, as well as access to inputs;
- Better market participation of emerging farmers through public-private partnerships; and
- Food security risk management - including increased investment in research and technology to respond to the production opportunities and challenges inherent to **climate change**, bio-energy, green technologies and the like

1.4.2.2 Rural Development

The Department of Rural Development and Land Reform (DRLDR) was established in 2009 to manage rural socio-economic development. The Comprehensive Rural Development Programme Framework (CRDP) was published in conjunction with the establishment of the new department. The CRDP has an overall strategic objective of facilitating integrated development and social cohesion through participatory approaches in partnership with all sectors of society. The CRDP is structured around strategic three pillars, namely: Improved land reform; Agrarian transformation; and increased strategic rural development. The strategy outlines a set mutually reinforcing objectives which includes[12]:

- Development of a mitigation and adaptation strategies to reduce vulnerabilities with special reference to climate change, erosion, flooding and other natural disasters;
- Increased production and sustainable use of natural resources;
- Development of unstainable rural livelihoods;
- Use of appropriate technologies, modern approaches and indigenous knowledge systems;
- Food security, dignity and improved quality of life for rural households;
- Implement community empowerment initiatives; and

[10] Department of Agriculture, Forestry and Fisheries. 2012. Integrated Growth and Development Plan. Pretoria, South Africa.

[11] Department of Agriculture, Forestry and Fisheries. 2015. 2015/16 to 2019/20 Strategic Plan. Pretoria, South Africa.

[12] Department: Rural Development and Land Reform. 2009. Comprehensive Rural Development Programme Framework. Pretoria, South Africa.

- Democratization of rural development, participation and ownership of all processes, projects and programmes and participation of Non-Governmental Organisations, Community Based Organisations and other organs of civil society.

The roll out of the CRDP to all municipalities has been highlighted as a key priority in the DRDLR's most recent strategic plan. At present the Strategic Plan[13] does to directly address climate change, but the DRDLR has since compiled a Climate Change Adaptation Sector Plan for Rural Human Settlements.

The sector plan acknowledges the risk posed by climate change to the DRDLR's ability to fulfil their internal mandates. The adaptation plan recognises the vulnerability rural households to climate change, with specific reference to their reliance on subsistence farming, and addresses the mandate for sector based adaptation plans as outlined by the NCCR. The Plan focussed on a coordinated and people-centred response to climate change risk and vulnerabilities faced by rural communities, guided by the following objectives[14]:

- Objective 1: Support the development of community and local climate adaptation plans;
- Objective 2: Build local adaptive capacity through supporting sustainable livelihoods;
- Objective 3: Support sustainable land management that promotes climate resilience;
- Objective 4: Protect ecosystem services to rural communities;
- Objective 5: Promote access to climate resilient services and infrastructure;
- Objective 6: Strengthen disaster preparedness and response; and
- Objective 7: Invest in long term research on more effective ways to supports rural household climate resilience.

In KwaZulu-Natal the Department of Agriculture and Rural Development facilitates the implementation of the national policies discussed above on a provincial level. Agricultural Policy Action Plan: 2014-2019 and Agriculture and Rural Development Strategic Plan: 2015-2022 outlines the creation of an enabling environment that facilitates private sector investment and socio-economic development in rural areas, with agriculture as the driver. On a provincial level the Agriculture and Rural Development policy context recognises potential threat of climate change and subsequently the need for sustainable and climate smart agriculture. Interventions already put forward includes the establishment protected areas, the development of focussed adaptation and mitigation strategies, diversification of crops and livestock to increase climate resilience, the financial support mechanism for subsistence and small-scale farmers.

1.4.2.3 Water

South Africa has tiered water policy and planning regime, aligned from national to local level and structured horizontally around the integrated themes of water resource management, water resource infrastructure and water services.

For the next 20 years water management in South Africa is to be guided by the National Water Resource Strategy[15] (NWRS2) (2012). The NWRS2 notes the fact that the effects of climate change will have a progressive impact on South African water resources with an inevitable increase in water stress. The Strategy proposes the development of adequate capacity within the sector and the country for monitoring, early warning and adaptation climate related water stress, to ensure sustainable water supplies into the future. Due to the critical role water security plays in wide range of systems, the NWRS2

[13] Department: Rural Development and Land Reform. 2015. Strategic Plan 2015-2020. Pretoria, South Africa.

[14] Department: Rural Development and Land Reform. 2013. Climate Change Adaptation Sector Strategy for Rural Human Settlements. Pretoria, South Africa.

[15] Department of Water Affairs. 2013. National Water Resource Strategy: Second Edition.

recommend that effective water resource management should be top priority as the ability to reconcile demand and supply will be imperative in improving livelihoods and maintaining economic growth.

The NWRS2 outlines key objectives for the water sector strategic climate change response[16]:

- Reduce the vulnerability and enhance the resilience of communities, people, enterprises and ecosystems, to water-related impacts of climate change, particularly for those groups most at risk;
- Improve and enhance water resources management processes to build the required resilience and adaptive capacity;
- Integrate climate change considerations into short-, medium- and long-term water planning processes for water resources and water services;
- Implement the best catchment and water management practices to maximise the degree of water security and resource protection under changing climatic conditions;
- Enhance the human, legal, regulatory, institutional, governance and financial resources and capacity to assist with the effects of climate change on water;
- Undertake focused monitoring and research to ensure the efficacy of water adaptation approaches over the long term; and
- Ensure inter-linked climate and hydrological modelling tools that represent the complex interrelated natural systems.

In support of these objectives the NWRS2 recommended specific strategic actions addressing key water governance and infrastructure related measures. While the measures are emphasised according to their significance for climate change response, the cut across various other sections of the NWSR2. The department is currently developing a National Climate Change Strategy for Water Resources.

[16] Department of Water Affairs. 2013. National Water Resource Strategy: Second Edition. Page 75.

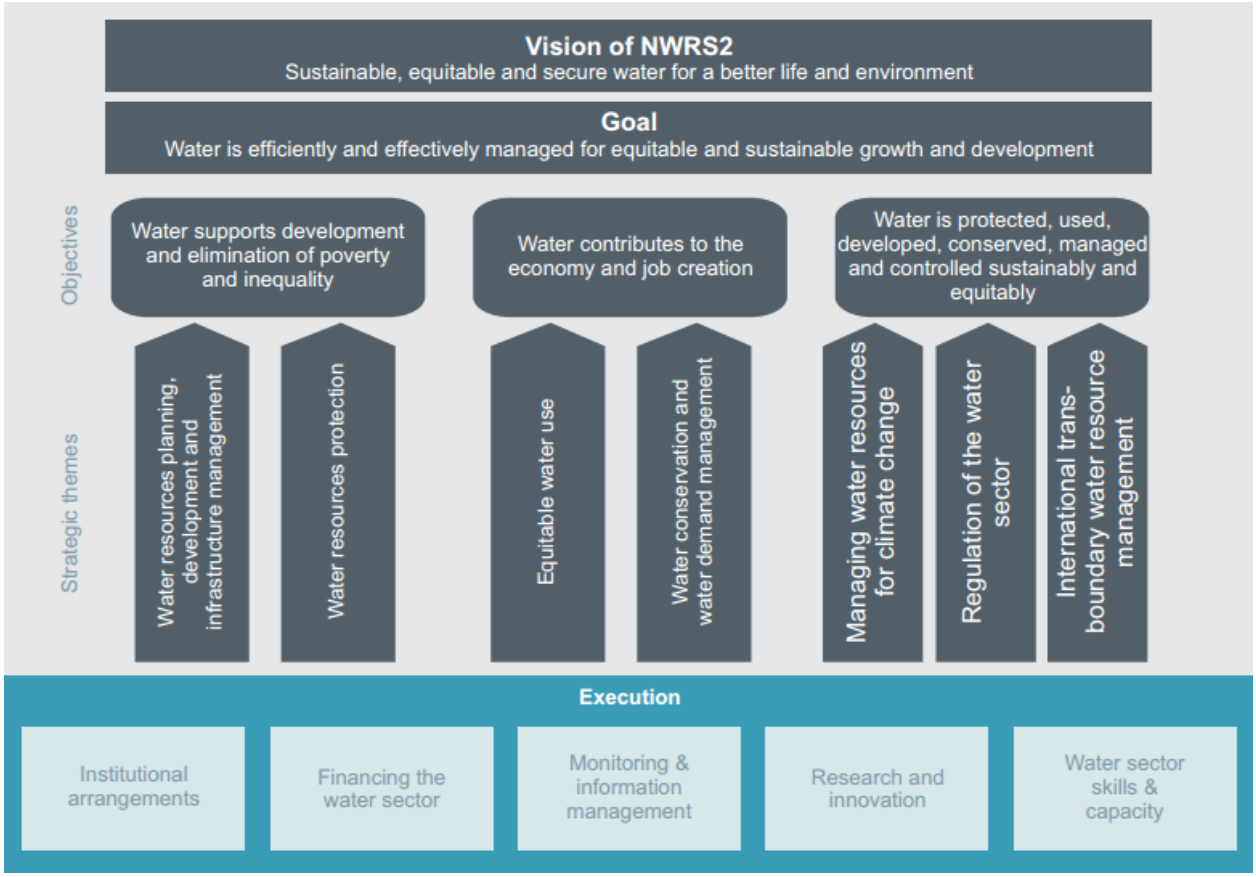


Figure 1 Overview of the NWRS2 Strategy from vision to execution

1.4.2.4 Energy

Energy plays a central role in the economy and is key to achieving various national strategic objectives. On a national level, this sector is overseen by the National Department of Energy. While obtaining their primary mandate from the White Paper on Energy Policy of 1998 and National Energy Act, 2008 (Act No. 34 of 2008, a range of supplementary energy policies have been developed and implemented in the recent past which includes:

- The Renewable Energy White Paper (2003)
- The Integrated Energy Plan (IEP);
- The National Energy Efficiency Strategy (NEES)
- The National Energy Efficiency Action Plan (NEEAP);
- The National Energy Act (Act No. 34 of 2008);
- The Electricity Regulation Act (Act No. 4 of 2006), Second Amendment (2011);
- The Amendment to the Electricity Regulations on new generation capacity (18 August 2015).

Arguably the most significant of these is the IEP, which is currently under development and will guide and integrated approach to energy planning on national level aimed at optimising the energy system.

1.4.2.5 Built Environment

Climate change will not only on people's livelihoods but also on local (and national) government infrastructure required to provide basic services. Infrastructure is a cross-cutting issues which involves various sectors. It is very likely that national government will need to support local initiatives not only through clear policy guidelines, but also financial assistance.

The NCCRP proposes strategies for transport and infrastructure related resilience which includes:

- Promoting urban densification to build climate resilient infrastructure;
- Improving climate resilience of low-cost housing;
- Encouraging water-sensitive urban design; and
- Incorporating down-scaling of climate projections and effective information and assessment tools to inform land-use planning and urban design that is climate resilient;
- Support the development of energy efficiency and renewable energy plans for cities and towns and support their implementation;
- Initiate research to identify the factors that would determine urban resilience;
- Conduct research to determine appropriate monitoring and assessment tools with which to evaluate a city's ongoing resilience;
- Regulate commercial building standards with a view to enforcing green building construction practices;
- Mandate the National Home Builders Registration Council (NHBRC) to ensure that building construction conforms to green building requirements, including measures such as use of controlled ventilation, recycled material, solar power;
- Broaden the mandate of the Construction Industry Development Board (CIDB) to include green building and construction practices as a specific requirement to be met by contractors who wish to participate in the public tendering system to build schools, clinics, roads, bridges, dams, stadiums and other public infrastructure;
- Strengthen and enhance decision support tools and systems such as the Toolkit for Integrated Planning.

While the NDP and NSSD considers the implications of climate change on infrastructure and provides high level guidance on sustainable development, there is no integrated approach to addressing climate change risk within the context of infrastructure development and asset management as of yet. To date it has largely addressed within sectoral strategies and plan mentioned above, with an emphasis on water, energy and transport.

1.4.2.6 Disaster Management

The National Climate Change Response Paper (NCCRP) and the Second National Communication (SNC) to the UNFCCC, highlighted disaster management as a key area of development, for the country due to the expected increase in extreme climatic events, heat waves, drought, wild fires, floods and storm surges linked to climate change. This commitment is illustrated by the fact that the national government's investment in disaster risk reduction and emergency response sector has risen from US$0.02 bn to US$ 0.7 bn between 2010 and 2015, as part of the total increase of investment in adaptation which rose from US$ 1.64 bn to US$ 2.31[17].

Subsequently South Africa has made significant progress on various levels with regards to acknowledging reciprocal relationship between climate change and disaster risk and facilitating greater integration between climate change science and response and disaster risk management, including the establishment of one of Africa's most advanced early warning systems (EWS).

[17] South Africa, G. o., 2015. South Africa's Intended Nationally Determined Contribution (INDC). [Online] Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/South%20Africa/1/South%20Africa.pdf

One of the most significant development in terms of the sectoral policy context, since the SNC, has been the Disaster Management Amendment Act No.16 of 2015. The Act now explicitly provides for the inclusion of climate change in disaster risk assessments through all spheres of government and mandates measures to reduce the risk of disaster through adaptation to climate change and the development of early warning mechanisms. This legal directive gives further weight to South Africa's progressive legislation and policy instruments for disaster risk reduction and their application in support of climate change response for supporting climate. Furthermore the Disaster Management Amendment Act is aimed at addressing the challenges that has resulted in poor institutional implementation at local government level.

Addressing the challenges faced in the implementation of the Disaster Management Act and National Disaster Management Framework will have a positive impact on disaster risk reduction and climate change adaptation especially for key economic sectors such as agriculture, water housing and environment sectors, and the effectiveness of EWSs in the country[18].

1.4.2.7 Health

The IPCC emphasises the need for effective adaptation measures in the health sector, such as the provision of clean water and sanitation, increased capacity for disaster preparedness and response, improved surveillance and early warning systems and food security and nutrition, which has various cross-cutting implications.

Climate change and health adaptation has been considered at national level through the drafting of a National Climate and Health Adaptation Plan, however implementation are still at an early stage.

The National Climate Change Health and Adaptation Plan 2014– 2019 outlines several key training and capacity-building needs:

- Strengthen the provincial epidemic preparedness and response teams through scaled-up;
- Design and produce educational material on diarrhoeal diseases and meningococcal meningitis to increase community awareness;
- Resuscitate the Water, Sanitation and Hygiene Committee to plan and coordinate key activities toward the prevention and control of sanitation and water-related diseases;
- Strengthen programmes and activities related to improved industrial and household waste management for the prevention of disease, including health education and awareness;
- Improve surveillance and reporting of cases toward early detection and case management of key diseases;
- Improve awareness and training on malaria and cholera outbreaks, and how these can be dealt with proactively and prevented.

1.4.3 Provincial Level

Climate change impacts all spheres of Government highlighting the importance of enhanced coordination and policy alignment. According to the National Climate Change Response Policy the political and technical structures required to facilitate policy and strategy alignment between the spheres of government has been established through the Intergovernmental Relations Act

[18] DEA, 2014a. Climate Information and Early Warning Systems for Supporting the Disaster Risk Reduction and Management Sector in South Africa under Future Climates. REPORT No. 2 FOR THE LONG TERM ADAPTATION SCENARIOS FLAGSHIP RESEARCH PROGRAM (LTAS), s.l.: Department of Environmental Affairs, South Africa.

The KwaZulu-Natal provincial Government realizes that climate change is a complex cross-cutting issue which cannot be addressed by one government department alone. The effective integration of adaptation and mitigation measures require the acknowledgement and prioritization of climate change within many government departments within all spheres of government and across the administration as a whole.

A Provincial climate change vulnerability assessment was completed in 2009. It provided insights on potential impacts and vulnerable sectors, priority risks, information gaps and existing response measures. The study has been shared with municipalities across the province to inform municipal level climate change response and awareness campaigns.

The Climate Change Response has been included as a strategic goal in the Provincial Growth and Development Strategy (PGDS), acknowledging the potential impact of climate change on economic growth, food security and sustainable resource management[19]. The PGDS indicates a clear provincial commitment towards climate resilience in line with the NDPP 2030. The PGDS specifically mentions the ability of the Mvoti-Mzimkhulu Water Management Area (WMA) to water demand as a motivating factor for an effective climate change response.

Subsequently the KwaZulu-Natal Provincial Department of Economic Development and Tourism developed the KZN Green Economy Strategy (2013). The KZN Green Economy Strategy is supported by an online platform (www.kzngreengrowth.com).

Additional supporting structures relevant to the provincial response to climate change, includes:

- KZN Council for Climate Change and Sustainable Development established in 2012 to coordinate climate change management activities in the province;
- KZN Renewable Energy Working Group;
- Central KwaZulu-Natal Climate Change Compact (CKZNCCC) formed to facilitate information sharing and collaboration on climate change adaptation projects.

The emerging roles and responsibilities of local government in terms of climate change adaptation remains unclear. These roles and responsibilities need to be incorporated into existing applicable policies and legislation, relating to the functions and powers of local government in order to enable a sustainable future climate change response.

1.4.4 Local Level: Ugu District Municipality

In South Africa, local governments' approach to climate change still exhibits various gaps that are preventing them from being particularly effective or innovative in actively dealing with climate change. In the Ugu District, as is generally the case across the country, the need exists for operative municipal level policies and mechanisms that address the challenges and opportunities posed by climate change. This is only possible if elected and appointed officials reach consensus to treat climate change and required adaption as a top priority.

Although current fiscal arrangements do not always allow for or incentivize the mainstreaming of climate change response into local government activities, local government is a critical role-player in achieving climate resilience through the effective execution of their mandated duties. These duties include:

- Human settlement planning;
- Urban development;
- Provision of municipal infrastructure and services;
- Water and energy demand management; and
- Local disaster response.

The Ugu District has expressed commitment to following initiatives in support of Climate Change Response:

[19] KwaZulu-Natal Provincial Planning Commission. 2011. Provincial Growth and Development Strategy.

- Air pollution monitoring;
- Air Quality Management plan;
- Air Quality Management bylaws;
- Community based greening initiatives;
- Invasive Alien Species Forum;
- Education and awareness campaigns – schools and communities;
- Development of the Environmental Management Framework;
- Municipal environmental policy that promotes Green offices and green procurement;
- Provincial Climate Change Vulnerability Assessment;
- National Climate Change Response Policy.

It should be noted that although to date the Ugu DM has taken positive steps working towards achieving initiatives climate change remains a secondary priority, competing with other short term critical issues. Intent to prioritise climate change adaptation is further hindered by insufficient acknowledgement of the reality of climate change by relevant stakeholders.

The majority of the climate change related initiatives and actions in the Ugu DM has been implemented under the guise of Air Quality and Biodiversity Management and in moving towards a *green economy*, rather than being explicitly linked to climate change and climate change response.

Based on the current status quo climate change response actions remains largely reactionary or response driven and uncoordinated within the Ugu DM and local municipalities.

Apart from the Ugu DM's responsibilities in terms of Climate Change Response, community level responses will also play an important in the District's approach to climate change. Across the district there is already evidence that people are developing adaptation strategies to water stress and lack of resources, especially in the agricultural sectors. This is encouraging as the agricultural sector, on commercial and subsistence level, is of critical importance to the Ugu DM. While adaptation strategies such as traditional seed banks and cultivation of traditionally drought resistant crops are being observed, a large number of farmers are still not fully comprehending the potential impacts of climate change, how this is impacting the climate baseline from which the season weather acts and not taking appropriate action before, during or after experiencing the particular anomalous events associated with climate change. Examples of this would be the observed shift in rainfall seasonality (onset and cessation) and the reluctance of farmers to utilise and adapt planting timing and/or variety to seasonal forecasts.

1.4.5 Mainstreaming aspects

The Ugu District and its local municipalities have a crucial role to play in facilitating climate resilience through the performance of mandated responsibilities. These include human settlement planning, urban development, provision of municipal infrastructure and basic services, water and energy demand management and local disaster management.

A key component of the Strategy will be the "mainstreaming" of climate change. Mainstreaming of climate change response implies that local government adopt, expand and enhance the climate risk measures into their normal planning processes and existing everyday activities and functions[20]. Adaptation to climate change will require both standalone policies and integration into development planning tools such as Integrated Development Plans (IDP) and Spatial Development Frameworks (SDF).

The figure below illustrates the planning context in relation to other regional processes and subsequent products, but also with regard to the cyclical nature of the development agenda.

[20] IPCC. 2014. Summary for Policy Makers. In: Climate Change 2014: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

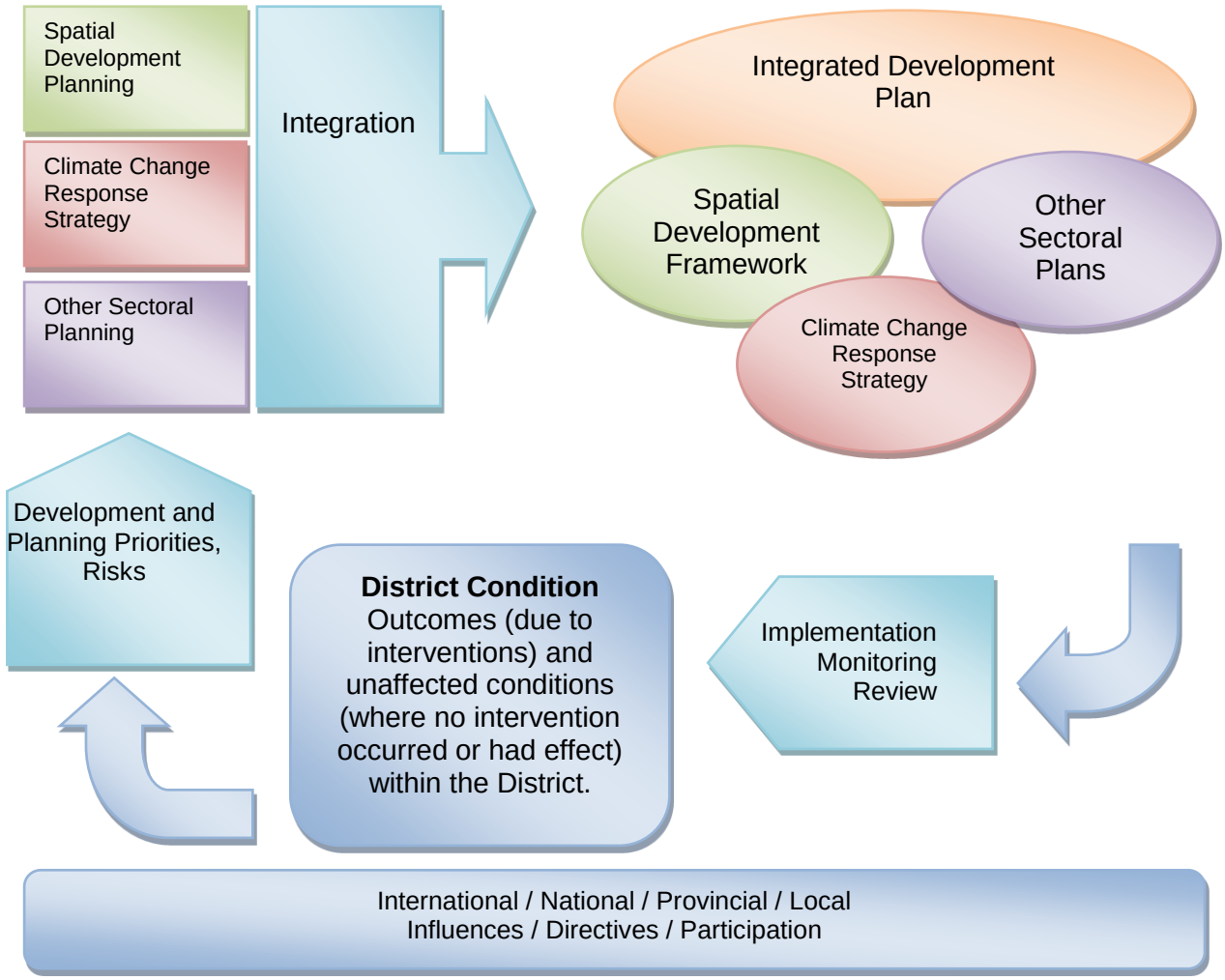


Figure 2: The Relationship between the SDF, IDP and Climate Change Response Strategy

The mainstreaming of climate change response into existing frameworks will ensure more efficient use of resources in the Ugu District and local municipalities as well as the increase the beneficial interactions between climate change response and development.

The mainstreaming of climate change into all municipal sectors will allow for the gradual implementation of climate change response measures within existing budgets balancing incremental costs with the economic, environmental and social values produced, realising no-regrets interventions, rather than necessitating additional dedicated climate change budgets in an already resource scarce municipal context.

The concept and process of mainstreaming is central to facilitating successful climate change responses at a local level. It is integrated component of the overall response strategy which is unpacked in greater detail in Chapter 5 and 6.

2 Situational analysis

Building on the policy and response context, from international best practice through national structures and to local municipality level, the situational analysis presents the status quo as it relates to Ugu DM. The analysis presents the municipal profile spatially and qualitatively, highlighting key variables as it relates to vulnerability and exposure to climate change risks and short term meteorological hazards. This review was undertaken through analysis of socio-economic indicators such as population density, income and education, area economic and development duality, as well as institutional capacities, service delivery to communities and sector based climate exposure and support by stakeholder engagement.

2.1 Municipality profile

The Ugu District Municipality comprises of six local municipalities:

- Hibiscus Coast Local Municipality
- Izinqoleni Local Municipality
- Umuziwabantu Local Municipality
- Vulamehlo Local Municipality
- Umzumbe Local Municipality
- Umdoni Local Municipality

The municipality is situated in southern KwaZulu Natal and is bordered by Ethekwini Municipality (north), Umgungundlovu District Municipality (west), Sisonke District Municipality (west) and the Eastern Cape Province (south) (Figure 1).

The Ugu District Municipality has a well-developed coast with good infrastructure and inland rural areas with limited infrastructure. The inland areas are largely characterised by commercial and subsistence agricultural activities. The District's historical climatic patterns are characterised by summer rainfall and sub-tropical conditions. A more detailed overview is provided as part of the Climate Analysis in Section 3.

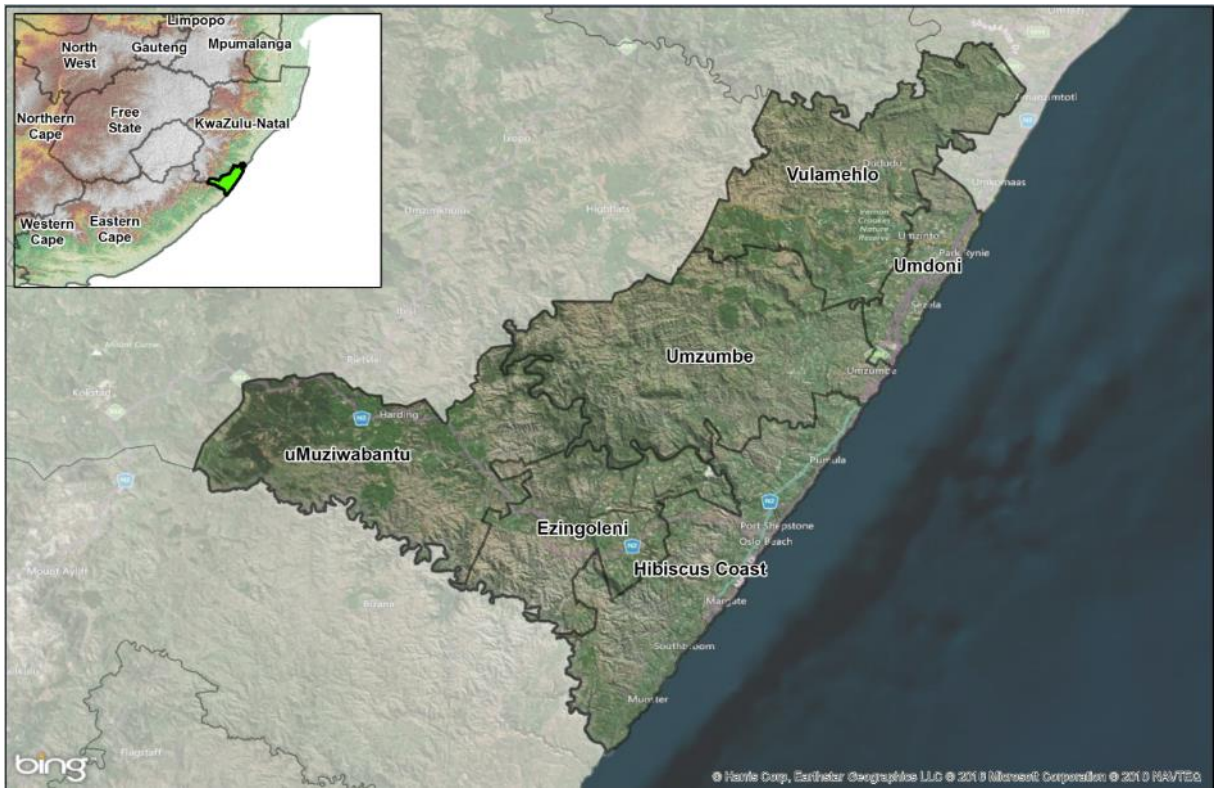


Figure 3 - Locality of Ugu District Municipality and Local Municipalities

A brief overview of the district follows below[21].

2.1.1 Spatial demographic Profile

The total population for the district is 722484 (Census 2011) with 86% of the Districts' population located in rural areas. The District's population consists of a large number of youth who aspire to move into metro areas due to the limited opportunities for development and entertainment in the District. This could cause implications for the District as the young productive population declines[22]. The total area of the District is 5 866 km^2.

[21] For a more detailed situational analysis please refer to the Ugu District IDP

[22] Ugu District Growth and Development Strategy, 2012.

2.1.1.1 Hibiscus Coast Local Municipality

Hibiscus Coast Local Municipality has its administrative seat in Port Shepstone. The municipality has approximately 90km of coastline comprising 21 beaches, and extends 30km inland, covering a vast, rural area under the leadership of six tribal authorities. It is the most concentrated economic hub within the Ugu District Municipality in the KwaZulu-Natal province.

The Hibiscus Coast Local Municipality is home to the largest population share (35%) of the District. The municipality has an area of approximately 837km2 and comprises of 29 wards. More people live along the coastal belt than the rural hinterland due to economic factors.

The main economic sectors include:

- Finance and business services;
- Wholesale and retail;
- General government services; and
- Agriculture and forestry.

2.1.1.2 Izinqoleni Local Municipality

The Izinqoleni Local Municipality is located in the south western area of Ugu District Municipality adjacent to the west of the Hibiscus Coast Municipality and east of the Umuziwabantu Municipality, and has an area of 649km^2. About 7% of the District's population resides in Izinqoleni Local Municipality.

The Izinqoleni municipal offices are situated within the Izinqoleni settlement, which is located some 40km west from Port Shepstone along the N2 National Highway. The major land uses in the area are tribal settlements, smallholdings and commercial farming.

The main economic sectors include:

- Agriculture;
- Tourism; and
- Services.

2.1.1.3 Umuziwabantu Local Municipality

Umuziwabantu Local Municipality is located on the western boundary of the Ugu District area. It lies at the foot of the Ingeli Mountain Range and the Umtamvuna River marks the southern boundary. It shares its borders to the north, west and south with the Eastern Cape and to the east with the uMzumbe and Izinqoleni Municipalities.

The municipality covers a total area of approximately 1088km^2, and about 13% of the District's population resides in Umuziwabantu Local Municipality. Significant features include an urban development (the town of Harding), farmland, commercially-grown forests, and traditional authority areas.

2.1.1.4 Vulamehlo Local Municipality

Vulamehlo Local Municipality is bordered by Umdoni to the east, Mkhambathini and Richmond to the north, and Ubuhlebezwe to the west. The municipal area covers 960km² is predominantly tribal, with common tribal land patterns. There are, however, also a few scattered pockets of privately owned land throughout the municipal area.

The dispersed, low-density settlement pattern makes the provision of physical and social infrastructure (roads, water, electricity, clinics, schools, and police stations) and the costs of installing, maintaining and operating the infrastructure very high.

Apart from the town of Harding, which is the seat of the municipality, 56% of the municipal area is occupied by individually-owned commercial farms and the Weza afforestation region. The six tribal authority areas (KwaMachi, KwaJala, KwaMbotho, KwaFodo, Dumisa and Bashweni) make up 42% of the municipality's land The main economic sectors include: • Manufacturing; • Agriculture; and Timber	The Vulamehlo Municipality is one of the localities within the Ugu District that is hardest hit by high unemployment levels, poverty and negative economic growth rate. The main economic sectors includes: • Agriculture; • Manufacturing; • Tourism; and Services.

2.1.1.5 Umzumbe Local Municipality	2.1.1.6 Umdoni Local Municipality
The Umzumbe Local Municipality is the largest local municipality in the District with an area of 1260km^2. About 22% of the District's population resides in Umzumbe Local Municipality. The municipality is located along the coastal strip of the Indian Ocean between uMthwalume and Mfazazana. The LM currently has a negative growth rate of 1.85%. Umzumbe Municipality is highly active in the areas of tourism, heritage and agricultural produce (Livestock, poultry and vegetables). The municipality also boasts numerous development opportunities, available to people of Umzumbe and to outside investors. The municipality has placed tourism at the top of the agenda. The main economic sectors include: • Agriculture; and • Tourism.	The Umdoni Local Municipality covers total area of 238km^2. It is made up of 10 wards, most of which are rural areas. Umdoni Municipality covers the areas of Amahlongwa, Amandawe, Umzinto, Ghandinagar, Shayamoya, Park Rynie, Scottburgh, Hazelwood, Asoka Heights, Malibu Heights, Pennington, Sezela, Ifafa, Bazley, Mtwalume, Malangeni and Esperanza. The municipality can be divided into three major land uses, being commercial agriculture, traditional authority areas and coastal urban nodes. The coastline stretches approximately 40km. The main economic sectors include: • Commercial Agriculture.

The Ugu District municipality profile (DCoG 2011) summarises the vulnerabilities and climate exposure of Ugu DM. DCoG has classified Izinqoleni, uMuziwabantu, Umzumbe and Vulamehlo as most vulnerable in terms of functionality, socio-economic profile and backlog status. These areas also have the highest poverty rating of approximately 70%.

Table 1: Ugu District Municipality profile (DCoG 2011)

Local Municipality	Classification	Poverty Rate (63.7% Ugu total)
Izinqoleni	Most vulnerable	75.60%
Hibiscus Coast	Second highest performing	47.49%
Umdoni	Second highest performing	43.42%
uMuziwabantu	Most vulnerable	72.75%
Umzumbe	Most vulnerable	74.77%
Vulamehlo	Most vulnerable	68.19%

2.1.1.7 Area type vulnerability

The ratio of urban / settlements, informal settlements and rural areas between the municipalities will act as informants to the spatial vulnerability of households in the district. Ugu has ~65.6% formalised housing, 4.5% informal areas and the remaining in rural traditional areas.

Urban and formalised areas will likely receive better quality of service delivery (including water and sanitation), have better roads and be more resilient to the meteorological impacts of climate changes. Urban areas and the population there in will however be subject to the impacts associated with climate changes directly through increased extreme event frequency and intensity for urban systems and infrastructure but will also experience the indirect ramifications impacting water and food security as well as economic and development pressure from compromised sustainability. The high population density of urban area expose additional people to impacts resulting climate impacts. It has been noted that differing urban settlements are exposed to a varying degree not only through the singular hazard or disaster-event but also from the limited or inefficient adaptation, protection and/or recovery procedures. For example, poor stormwater maintenance can exemplify relatively minor rainstorms to a disastrous flooding event, therefore meteorological hazards marginally more severe than noted in the historical record could be a disaster[23].

Rural areas tend to have few services or access to funding and therefore will be less likely to proactively adopt climate resilient development. These areas tend to have a decreased population density thereby reducing the exposure of a large number of people to a focused acute meteorological impact, yet the high dependency on natural resources for their livelihoods exposes them to longer term hazards such as drought and seasonal shifts. Areas suitable for agriculture (substance and commercial), forestry and recreation will move from traditionally stable areas. This exposure is heightened by an aging population with limited economic potential, high poverty and physical remoteness from services associated with the urban areas.

Informal settlement areas, developing through accelerated urban growth coupled with local authorities' inability to keep up and formalise the increased housing demand. Settlement is therefore occurring in an unplanned (often geographically and environmentally hazardous areas[24]) manner consisting of shacks and backyard dwellings and these receive diminished services[25] (if any) and consist of a high density population. Furthermore, construction materials will also be of a lower quality and more susceptible to weather hazards increasing the exposure of these areas to climate change hazards. Addressing the population vulnerability is done either through 'passive' in situ upgrading or through 'active' relocation to formalised areas. The impacts of climate change parameters will have to be assessed on a settlement by settlement basis due to differential risk exposure. For example, in areas with projected increases in extreme rainfall, settlements on a ridge would be less exposed that settlements in closer proximity to a river course or flood plain.
The expansion of informal settlements is expected to grow substantially within the next 20 years[26]] and thereby exposing further populations to enhanced climate change exposure.

Hibiscus Coast has the largest proportion (79%) of urban households (both formalised houses and flats). As most of the LM is either an economic hub or regional centre, there is associated infrastructure/services and the LM should therefore have a higher coping capacity for dealing and recovering from the impact of hazards. It should be noted that service delivery and infrastructure will be limited in the 5.6% informal areas where capacity is reduced. This is exacerbated further in Umdoni which has the highest proportion of informal areas (12.7%), the remaining population however is

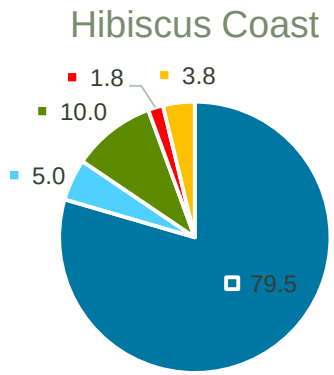
[23] Revi, Aromar (2007), Climate Change Risk: A Mitigation and Adaptation Agenda for Indian Cities, paper prepared for the Rockefeller Foundation's meeting on Building for Climate Change Resilience, Taru, New Delhi, 23 pages. A slightly condensed version of this will be published in Environment and Urbanization, Vol. 20, No. 1 (2008).

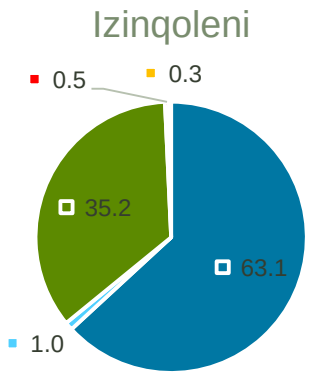
[24] UN-Habitat (2003), The Challenge of Slums; UN-Habitat (2013), The State of the World Cities Report 2012/13. Refer to Issue Paper No. 9 on Land for 'security of tenure' definition

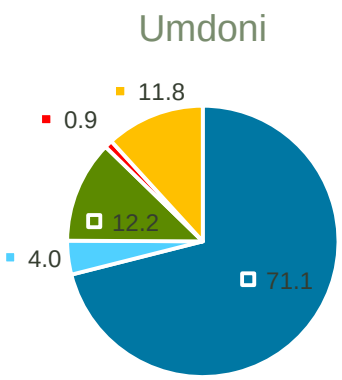
[25] World Bank (2008), Approaches to urban slums; UN-Habitat (2015), Streets as tools for urban transformation in slums; Cities Alliance (2010), Building Cities; Cities Alliance, World Bank and UN-Habitat (2002), Cities without Slums.

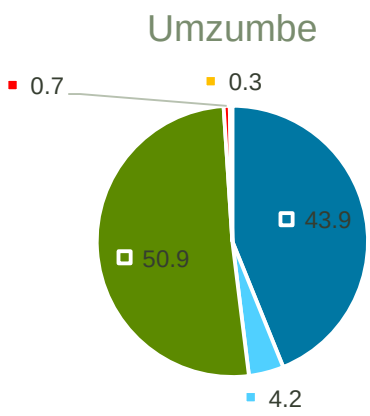
[26] UN-Habitat (2014), Slums and Cities Prosperity Index (CPI).

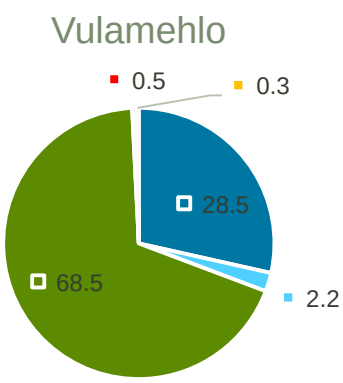
however in formalised housing in the economic city areas with higher resilience. Vulamehlo is showing a reversal of the urbanised situations noted in some of the other LMs with 68.5 rural/traditional dwellings and only 30.7% in formalised urban areas. The areas with more informal areas and with additional rural populations will have lower coping capacity and heightened exposure to longer and more sustained impact of disruptions.

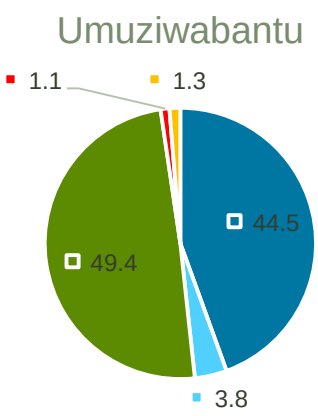












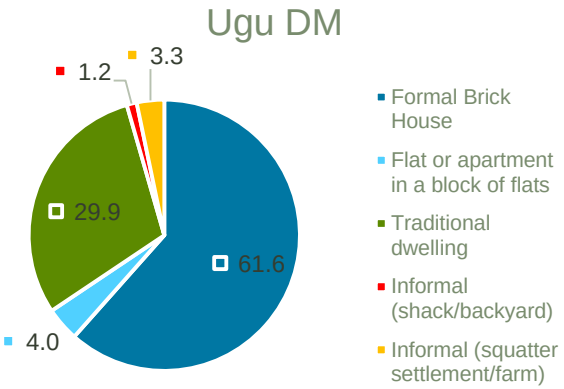


Figure 4: Proportion of Local municipality settlement type by household

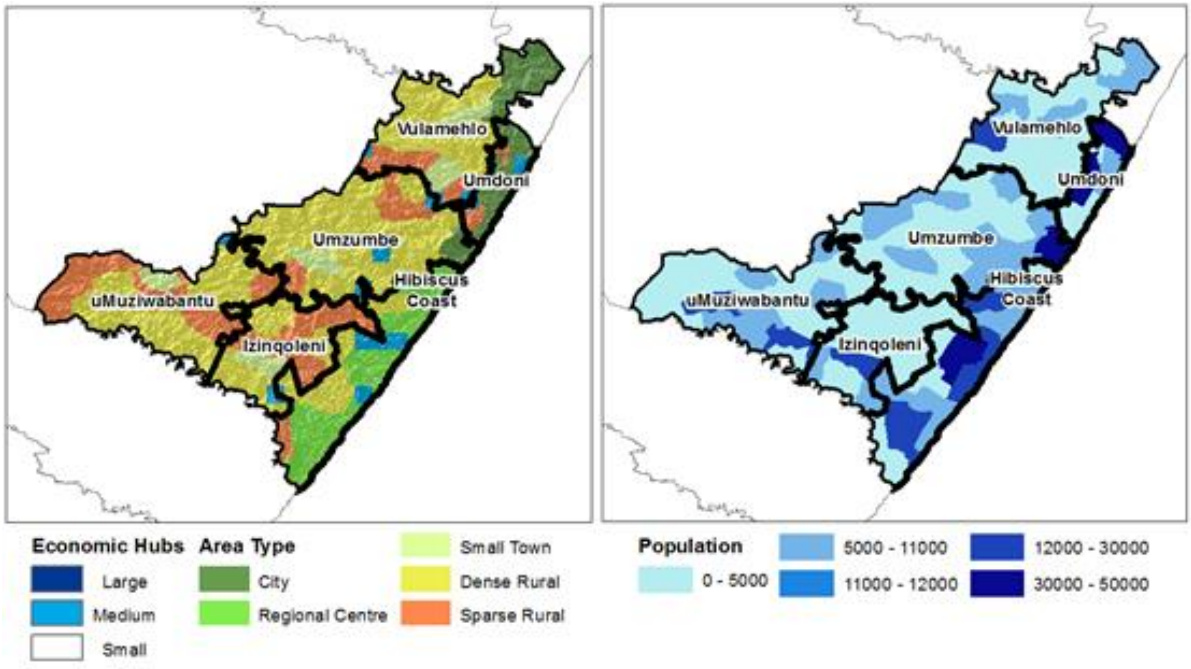


Figure 5: Area hubs and population density

Spatially there is a discrepancy event internal to the local municipalities. Economic hubs and area demarcated areas city/regional centres have the highest population densities. These areas tend to be along the coast in Hibiscus Coast, Umdoni, and to a limited extent Umzumbe. The area type often dictates the perception of vulnerability, however the settlement demographics indicate that generally urban settlements are more resilient than the rural areas, the exception to this being informal settlements. The households of the rural areas have more individuals with access to few services and hazard support thereby increasing vulnerability.

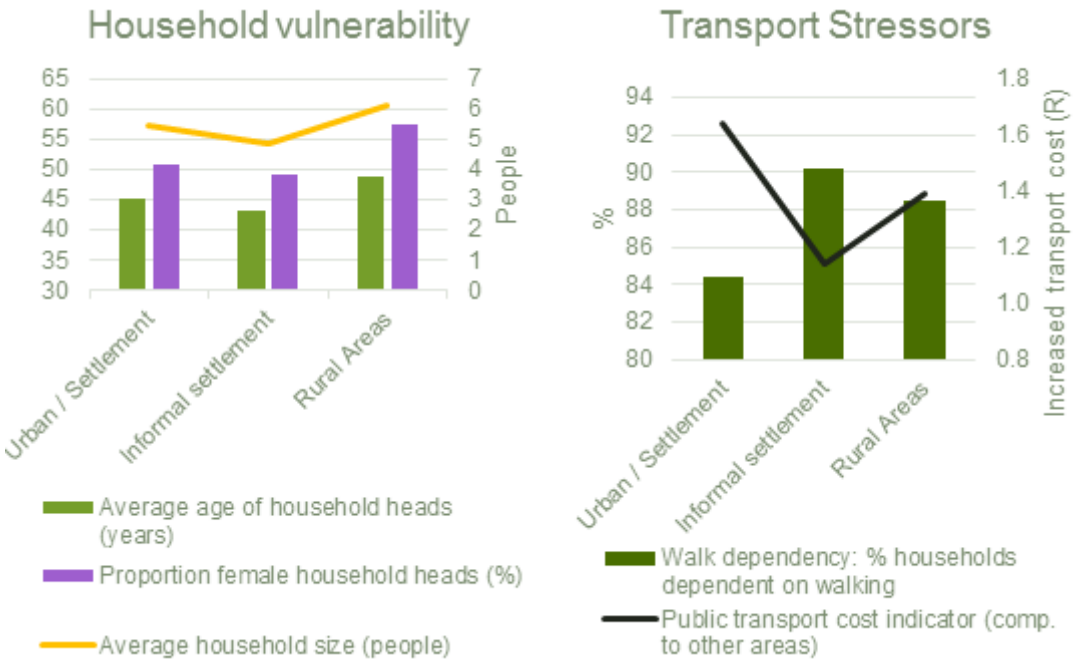


Figure 6: Demographic vulnerability per area type[27]

Household vulnerability is given by the proxies of household head age, household size and proportion of female headed households. Household head average age is lowest in the informal areas (43 years), followed by urbanised areas (45 years) and lastly rural areas (49 years). This disparity may result from the "bright lights" phenomenon in which work seeking younger people from the rural areas migrate to the urban but end up moving into the informal areas as a result of poor access to finance and stable income. These people tend to be inappropriately skilled for work opportunities in the urban areas. This is typified in the high density areas of Hibiscus Coast and Umdoni local municipalities.

Increased vulnerability is shown through the greatest proportion of female headed households (56%) occurrence in rural areas (primarily responsible for the burden of work), with Izinqoleni, Umzumbe and uMuziwabantu accounting for more than 60% in the rural areas. It should be noted that there are more female headed households in the formalised urban areas than in the informal areas suggesting that migration from the rural areas to the city tends to be the young males. This will impact family dynamics in the rural areas but also increase the vulnerability the female population in the informal areas particularly where they are the minority. This vulnerability is due to discrimination in access to labour markets, resources, finance, services, and influence[28].

Household size will alter the number of people exposed to a hazard but also the number of people relying on limited resources to mitigate impacts. Household size is highest in the rural (+6), then urban (5.5) and lastly informal areas (~5). This though may be a vulnerability misnomer as the informal area dwellings service smaller less stable families or groups. These dwellings also occupy significantly less space but are of higher density.

Access to transport services and less reliance on walking will increase community connectedness for day to day activities as well as in times of emergency. Furthermore it will enhance the ability of communities to seek employment opportunities further away from their homes and therefore increase their personal income potential. Reliance on walking as a means of transport is lowest in urban areas,

[27] Census 2011

[28] Morton, P.J.F. et al, 2014: Rural areas. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 613-657

and however to access this benefit costs more in the urban areas than elsewhere. Informal areas have the highest walking dependency due to limited access to personal vehicles. However transport services in these areas are less expensive than in the formalised urban areas, as there is a greater reliance on walking as the primary transport means.

The local level stakeholder engagements highlighted and reaffirmed the assessments of area type exposure and capacities above. Rural areas have decreased resilience over urbanised areas due to limited access to resources, services and infrastructure. They are less capacitated to cope with the impacts of a hazardous event.

Table 2: Exposure and capacities in area types – local perspective

Rural areas	***Urban areas***
Exposure	
• Population migration, children and elderly left in rural areas while working age population moves to urban areas. • Limited access to jobs (unskilled labour force), education/awareness of climate related impacts and resource competition. • Little to no infrastructure, service allocation and no access to finances/insurance. • Scattered settlements make combining services, resources, relief troublesome. • Exposed to natural hazards and disasters presently. Housing often mud huts. • Alien invasive contesting water resources, also providing additional fuel load for wildfires. • Environmental/soil degradation due to improper farming activities. • Low resilience to recover from hazard impact due to limited income and education.	• Urban heat island affect causing discomfort in the urban areas. • Local economy and food prices susceptible to impacts in the agricultural sector. • Areas in close proximity to the ocean may be at high risk. Significant spending on infrastructure and development in these areas will be lost. • Higher density of population living in inadequate housing being greater vulnerability to more people. • Industrialization and land transformation are having a negative impact on the environment. • Poor at dealing with pollution. Landfills and polluted water infiltration having negative effects. • Impermeable surfaces increase the effects of flooding. • High proportion of pensioners rather than working age professionals. • General disregard for environmental policies.
Capacity	
• Some awareness campaigns though policy education and compliance is very limited • Limited municipal investment and activity taking place. • Social cohesion between settlements. • More harmonious with natural systems and better at dealing with water pollution than urban areas. • Adoption of JoJo tanks for water storage. • Uptake of organic and permaculture farming practices	• Good infrastructure and service provision building the resilience of the urban areas. • Greening of urban areas. • Potentially more job opportunities in the urban areas. • Better coping capacities potential through access to goods, services, education and finance. • Greater disaster management capacity. • Personal capacity is higher due to income and education. • Generally dwellings have better construction materials and are more resilient. • Enhanced social and community structures to come together in a crisis

2.1.1.8 Economic factors influencing population exposure to hazard

Economic capacity is indicated though per capita monthly income, the relative unemployment and the dependency ratio, all of which indicate as the extent to which populations can mitigate against future, and recover from past hazardous impacts.

Urban areas have the highest monthly per capita income and also the lowest unemployed population. They also have a lower age household head (~45 years) than rural areas (48). These individuals in formal areas also earn significantly more monthly, have the lowest unemployment (20%) and are more economically active and able to cope financially than households of the informal and rural areas. Rural areas which often consist of subsistence populations has the lowest per capita income but also the lowest dependency ratio. Informal areas have the highest dependency ratio (~85%), the middle unemployment character and only marginally higher income per capita than rural areas. Previously these areas were often populated though rural-urban migration of the younger work seeking adults. However these informal areas are also growing from within. The factors that will decrease the economic resilience to a hazard are low income per capita, high unemployment and moderate to high dependency, these factors that will decrease the economic resilience to a hazard, coupled with the high population density, are exemplified in the informal areas.

Areas expressing the highest personal economic capacity and of lowered risk are those of the coastline in Hibiscus Coast and Umdoni. The north eastern part of Izinqoleni shows medium capacity, while the remaining areas shows medium/low to low personal financial capacity. Much of uMuziwabantu, Umzumbe and Vulamehlo is sparsely populated and relies on rural livelihoods or is an area of farming/forestry activity.

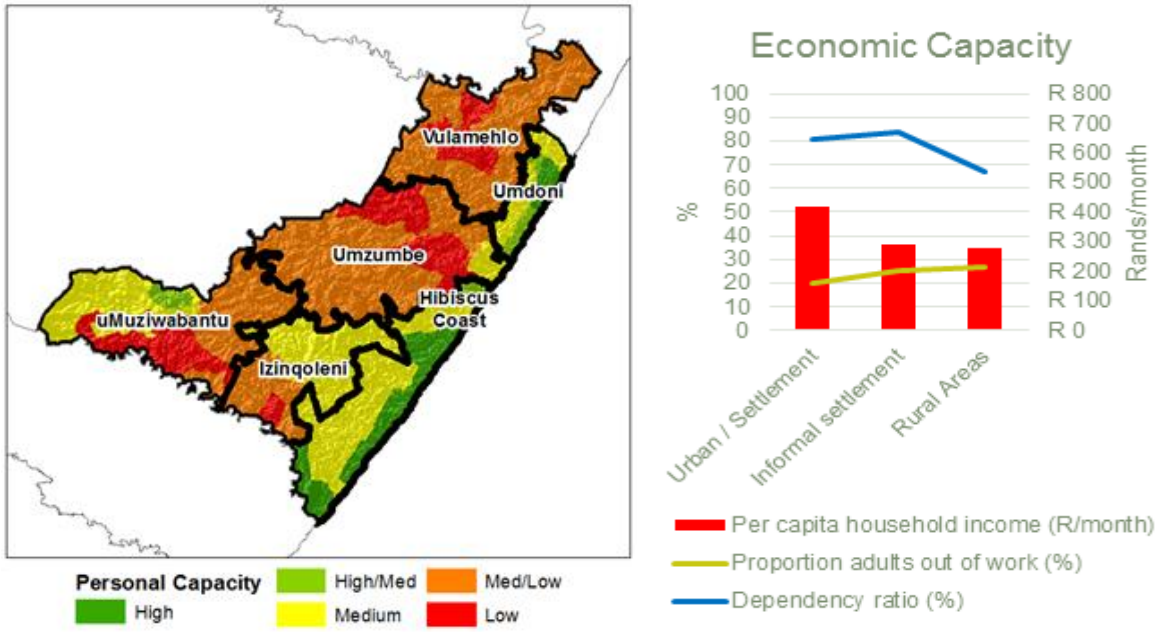


Figure 7: Socio economic vulnerability per area type and LM

Social economic changes over time suggest that positive changes have occurred with a decrease in the total and youth unemployment rates from 1996 to 2011 as well as indigent households. Unemployment however is currently still ~30% and the population that falls in this category will be less able to adapt to changes in climate hazards and are at heightened exposure, particularly as these populations likely correlate with the population of the informal areas. The annual income range shows disparity between 2001 and 2011 with the majority (45%) of the population falling within the middle annual income of R9601-R38 200. These residents are better cope with the impacts associated with a hazard through access to financing. It is unlikely though that these people will actively seek to mitigate exposure to future risks as these would be seen as a secondary or tertiary priority after day to day expenses.

Figure 8: Socio economic vulnerability change over time

2.1.1.9 Dual space of Ugu DM

The District can be categorised by a dual space economy and exposure profile. The area is effectively polarized between resilient urban coastal and high risk rural areas. "Spatially, the district is divided into an urbanised coastal zone with a relatively resilient and diversified formal economy and a largely impoverished rural interior with some large commercial farms (mainly sugar and bananas) and many struggling subsistence farmers. There is evidence of uneven environmental management resulting in degradation of some natural assets and resources[29].[1]" An estimated 50% of the total land area is made up of traditional authority areas. Uncontrolled development (especially in rural areas) is a concern in the District. This disparity between urban and rural has been driven through economic restructuring in the manufacturing and trade away from traditional sources toward the higher skilled products and services. This growth and development has in effect created partitioned district and divided the population going forward increasing social-economic inequality.

[29] Ugu DM Integrated Development Plan, 2012/13 - 2016/17 -2015/2016 Annual Review

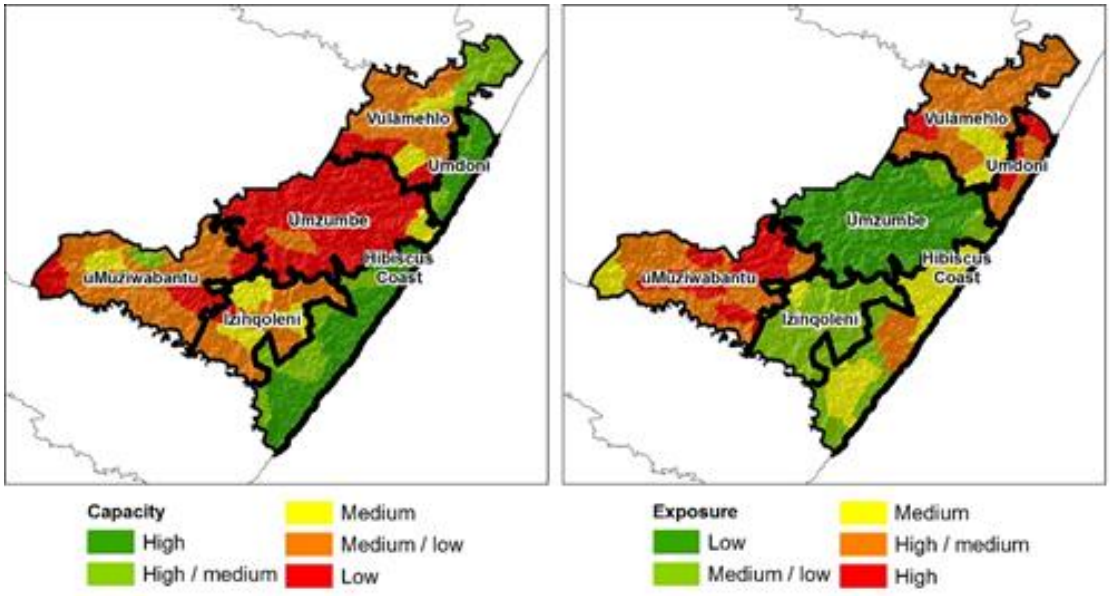


Figure 9: Capacity and exposure profile

Capacity and Exposure within Ugu DM highlights the disparity in the district between the resilient coastal and the vulnerable inland areas.

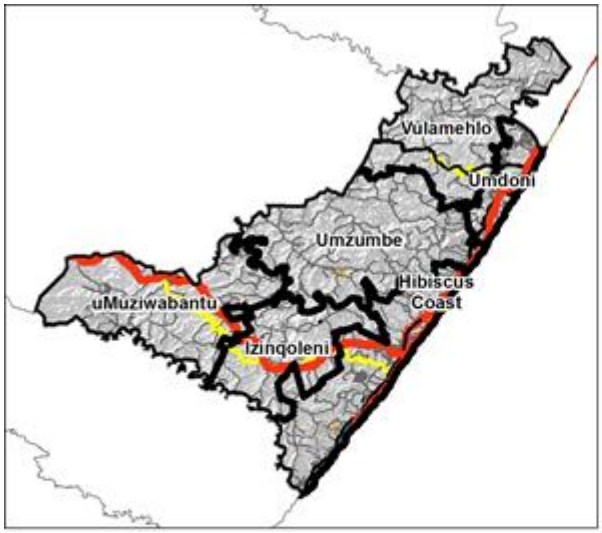
Capacity is measured by per capita income and education, institutional ability to cope with hazardous events, and economic contribution through business and industry. The coastal areas of Hibiscus Coast and Umdoni have generally high and high /medium capacity indexes implying greater manageability to changes in climate hazards a though both local government and personal resources. This coastal proximity effect is exemplified in Umzumbe municipality which has low or medium/low capacity throughout the area other than along the coast which has medium resilience. Much of the low capacity in Umzumbe is due to the rural nature and the lowered population density of this area. The fully inland municipalities of Vulamehlo, Umuziwabantu and Izinqoleni have variable manageability with the majority of the area being medium or medium low capacity, particularly in the rural areas. Areas and populations in the small towns of these local municipalities have access to work opportunities, trade, goods and services and ultimately have greater resilience.

Exposure to the impact of climate change hazards is measured though population density (risk to life and livelihoods), agricultural sensitivities and environmental integrity and protection. The coastal bias is less prevalent in the exposure with Umzumbe having moderate exposure to environmental impacts with the majority of the area marked as vulnerable rather than critically endangered as in noted along the high population density coastal belt. The significant agriculture and forestry areas as noted uMuziwabantu and Vulamehlo may be impacted severely by the accumulated projected climate changes likely in those areas.

Capacity to Cope / Manageability	Vulnerability / Exposure
An area with a high coping capacity will suffer decreased impacts from climate changes through its implemented adaptation measures and the policy capacity addressing climate change as a risk. Individual and institutional capacity is increased in areas with higher income and educational levels as well as areas benefiting from infrastructure and municipal services.	The vulnerability of an area is determined through assessing the risk to lives in densely populated areas, the potential impact to agricultural activities (commercial and subsistence), the status and ability of the environment to provide ecosystem services, and lastly the degree to which the climate is likely to change from the current baseline.

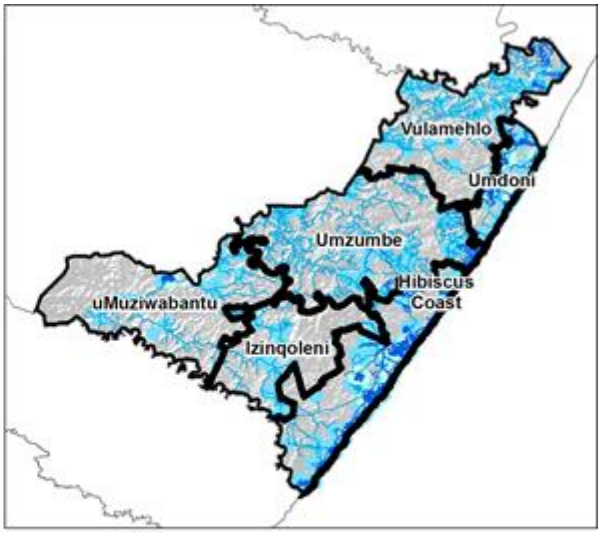
Measureable adaptation - area assessment and local feedback As climate change forcing originates largely outside of the study area, adaptation integrated into public and private projects is a more desirable way to build resilience and increase coping capacity. This measure is based on the assessment, research, and feedback from stakeholders and I&AP's.	**Population** Should areas with the larger populations, such as cities and dense rural areas be subject to unmitigated climate changes; the increased number of individuals affected will result in additional stress to be placed on institutional resources. Severe impacts in areas of heightened population density will cause disruption/risk to more lives and therefore is more vulnerable.
Personal Capacity A person's ability to respond to, and mitigate against current, projected, and unforeseen negative impacts is their individual personal capacity. Individuals (and groups of people) that are either unemployed and/or without education have diminished capability to positively alter negative happenings. The opposite is true for groups that have higher income and/or higher education. ***Income/employment thresholds*** i) No income/unemployed ii) Income < R1600.00 iii) Income < R12801.00 iv) Income > R12801.00 ***Education level thresholds*** i) No schooling ii) Schooling <= grade 7 iii) Schooling <= grade 12 iv) Schooling > grade 12	**Agricultural and plantation vulnerability** The land use indicates the proportion of a study area under commercial or subsistence agriculture or forestry. As the climate varies, suitability and viability of agriculture may be threatened. As such, an increased area under crop or forested may increase the vulnerability of an area.
Institutional Capacity and GDP Intuitional capacity is the degree to which a local authorities are able to respond to and mitigate against current, projected, and unforeseen negative impacts. Increased capacity is achieved from both a stable financial position as well as developed infrastructure. These act as proxy measures for the ability of an area to respond with appropriate and timeous intervention. **Area type capacity thresholds** i) Sparse Rural infrastructure and GDP capacity: 20% ii) Dense Rural infrastructure and GDP capacity: 40% iii) Local/Niche/Service Town infrastructure and GDP capacity: 60% iv) Regional Centre infrastructure and GDP capacity: 80 % v) City (vicinity) infrastructure and GDP capacity: 90% vi) City infrastructure and GDP capacity: 100%	**Environmental resilience** The land use indicates the proportion of a study area as vegetated, indigenous areas and grasslands. The encroachment into these natural areas diminishes the ecological integrity and compromises natural resilience support services. The degree to which natural vegetation is removed is proportional to the vulnerability of an area.

This disparity in terms of development between rural areas and formal urban settlements along the coastal strip is prevalent when addressing infrastructure deployment. Areas along the coast are better developed with regards to infrastructure including transport, water, electricity and sanitation compared to inland rural areas. The coastal areas have the National transport routes bringing in tourism and commerce to the region but also have connection through Izinqoleni and uMuziwabantu to further inland areas. Hibiscus coast and Umdoni also have the largest main and suburb road footprint allowing smooth access to the inhabited areas and businesses. The rural areas have a larger proportion of secondary and rural/farm roads and therefore will be impacted further from changes in the road surface through the impacts of heavy rain events. In terms of water infrastructure the inland area has additional bulk transport infrastructure though the majority is in unknown condition and may require maintenance. Hibiscus coast and Umdoni however have a majority of reticulation infrastructure providing water to houses and suburbs and therefore facilitating health benefits to the coastal areas rather than the inland areas.



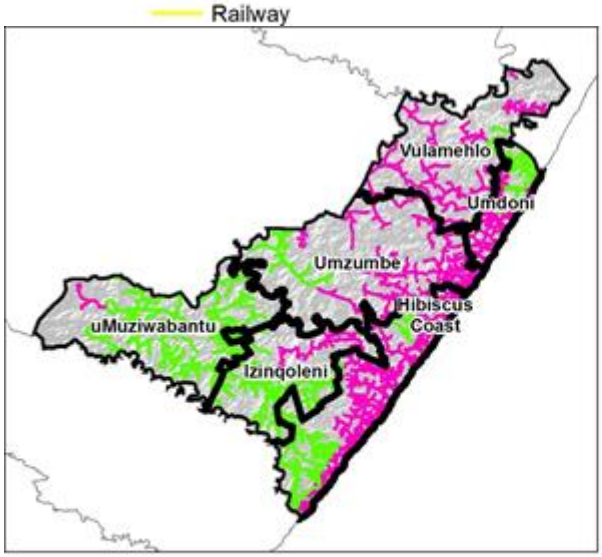
Transport infrastructure

- National Roads
- Main Roads
- Railway



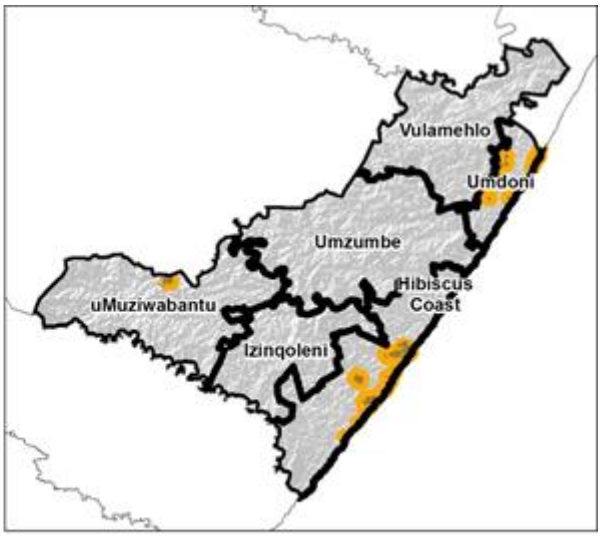
Water infrastructure

- Water - Reticulation
- Water - Bulk Supply
- Sewerage service
- Reservoirs and assets



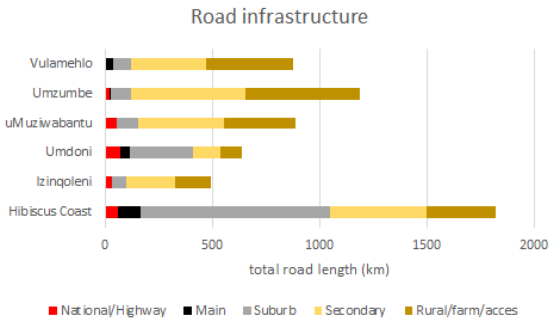
Eskom Distribution network

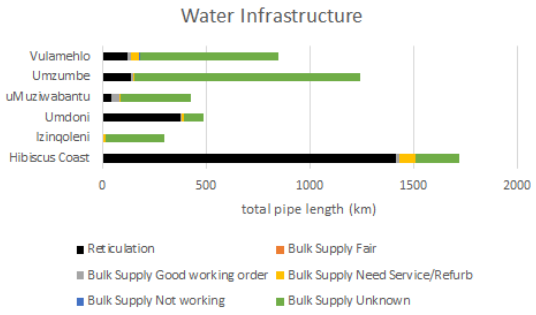
- 11.00 [kV]
- 22.00 [kV]



Sewer infrastructure

- Sewer pipes
- Sewer manholes





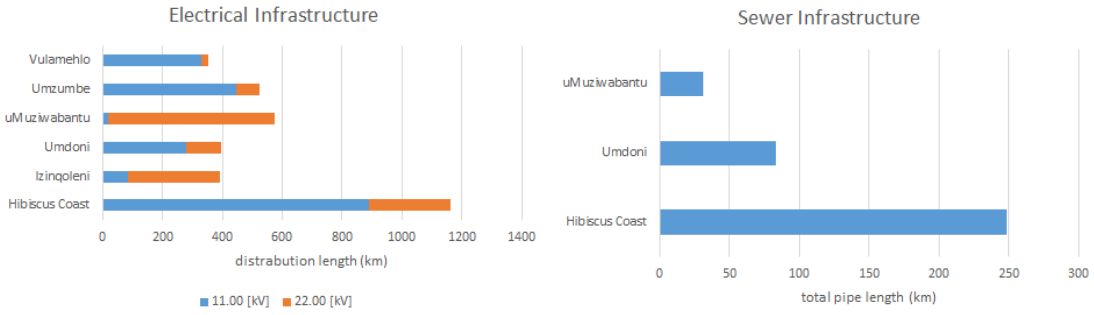


Figure 10: Road, water, electrical and sewerage infrastructure of Ugu

The electrical distribution network (excluding to the home connections) is primarily noted in Hibiscus coast. Umdoni and Umzumbe (particularly in the coastal areas) also have a strong network coverage. The inland areas of Umzumbe, Vulamehlo and Izinqoleni have rather spare distributions. Industry and development will be limited as a result of the insufficient capacities in these areas. The sewer infrastructure is highly isolated to the higher density areas between Port Shepstone and Margate in Hibiscus coast and Scottburgh and Umzinto in Umdoni but also in Harding in uMuziwabantu. Hibiscus coast however does have the majority of the sewerage infrastructure. There is very clearly a tendency toward the coastal areas in terms of development and infrastructure. Areas that have access to transport, electricity, water and sewerage will be better able to cope with a multitude of climate stressors over time, but also to acute meteorological hazards in the short term. However the Ugu DM's IDP highlights the most significant issue relating to the spatial development sphere as the increased illegal and uncontrolled development, and the subsequent need for improved enforcement of development controls. These informal settlements will lack the required infrastructural support thereby exposing the residents to climate and meteorological hazards and place delivery burden on the local authority to mitigate this exposure.

2.2 Economic Profile

The District has a relatively diversified economy with economic development potential in the agriculture, tourism, mining, retail and manufacturing sectors. Port Shepstone which is the main commercial centre and source of employment is a Secondary Node and the eThekwini-Ugu Corridor is a primary node. Approximately 40% of individuals in the district are not economically active and the majority of unemployed people are youth.

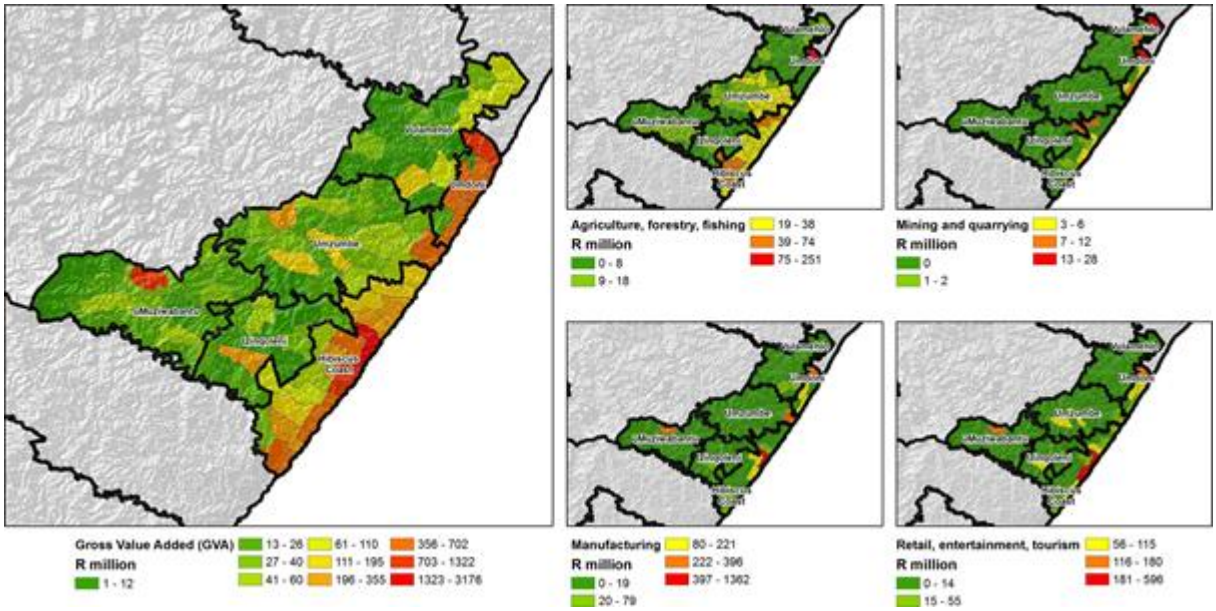


Figure 11: Economic activity in Ugu DM

2.2.1 Agriculture

The Agricultural Sector in the District is largely driven by commercial farming (sugar, bananas and macadamias; livestock), followed by subsistence farming (livestock, poultry, homestead gardening and dryland cropping on rural trust land. The district also has large forestry plantations, although processing does not take place within its borders.

Although KwaZulu Natal's agriculture sector contributes a small amount (approximately 4% in 2011) to the country's economy, Ugu's agricultural sector is a significant economic driver for the district. In recent years the agriculture sector has been characterized by negative growth rates and a steady increase in job losses. The number of commercial farms has also been decreasing. The District's agricultural sector faces many constraints such as, decreasing investment, rising production costs, a change of land use from agriculture to other land use. Climate change poses a significant risk to the agricultural sector, primarily linked to increased rainfall variability and water security. However, potential opportunities for agriculture exist and an enabling environment can be realized through effective information management, planning and implementation[30].

While climate change is considered as future concerns, there have already been observed impacts on the agricultural sector due to increased climate variability. For example, there are two commercial sugar mills located in the district. While demand is likely to require the mills to continue running at full capacity, water shortages has caused operational disruptions in recent times. Recent rainfall patterns has also brought the feasibility of continued dry-land cropping into question.

2.2.2 Mining

Mining does not contribute significantly to the economy of the District but supplies other industries with products such as animal fodder, fertilizer, paint, paper and plastic. The District's main mining industries produce limestone related products. The district has the only marble delta within KwaZulu Natal mined for cement and calcium carbonate. Illegal sand mining also takes place in the District.

[30] Ugu South Coast Development Agency (USCDA), Agriculture, http://www.scda.org.za/

While not contributing significantly to the economy, mining activities in the District does have a significant spatial and environmental footprint. Care must be taken to ensure mining applications are in line with municipal spatial and environmental plans.

2.2.3 Industry

Manufacturing is one of the largest contributors to the District's economy generating about R3 billion in 2011. The manufacturing sector grew by approximately 6% per year between 2000 and 2011. Industries and manufacturing activities are clustered around Port Shepstone and Marburg because of the available serviced land and connectivity to the N2 network. Main manufacturing activities taking place in the District include clothing and textiles, metal products, cement production, food, beverages and timber. Potential does exist however for the establishment of small-scale manufacturing activities within decentralised nodes, specifically for products that provide backward linkages to the agricultural sector.

There are 242 registered manufacturing enterprises in the district. As shown in the graph below, more than 75% of these are located in the Hibiscus Coast Local Municipality. Hibiscus Coast also generates the most revenue from manufacturing compared to the other local municipalities. Manufacturing in Hibiscus Coast mostly takes place along the coast and is one of the main sectors providing employment. Expanding formal large scale manufacturing enterprises into the rural areas of Hibiscus Coast is not envisaged even though it would provide job opportunities for the rural workforce.
Approximately 15% of the registered manufacturing enterprises are located in Umdoni. As the manufacturing sector expanded in Umdoni Local Municipality lighting, security, access and storm water management became insufficient. This eventually resulted in the deterioration of industrial parks which sparked upgrades and the planning of extending industrial parks in Umdoni. Future growth of the manufacturing sector may increase the demand for skilled labour. 7% of the remaining registered manufacturing enterprises are located in uMuziwabantu and 1% in Izinqoleni. Manufacturing activities such as timber manufacturing is declining in Izinqoleni Local Municipality which is negatively impacting the municipality's competitive advantage. Provision should be made to support existing and future manufacturing areas within Izinqoleni Local Municipality.

The figure also shows the percentage of different manufacturing activities occurring in each of the abovementioned Local Municipalities. Many of the registered manufacturing enterprises are optimistic about their businesses growing in future but some enterprises are constrained by skills, labour, transport, road infrastructure and finances.

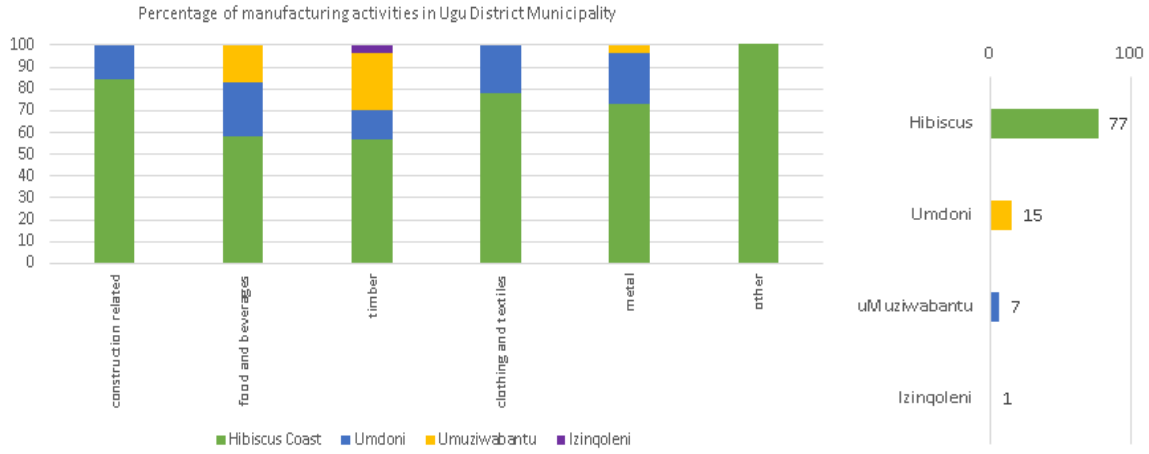
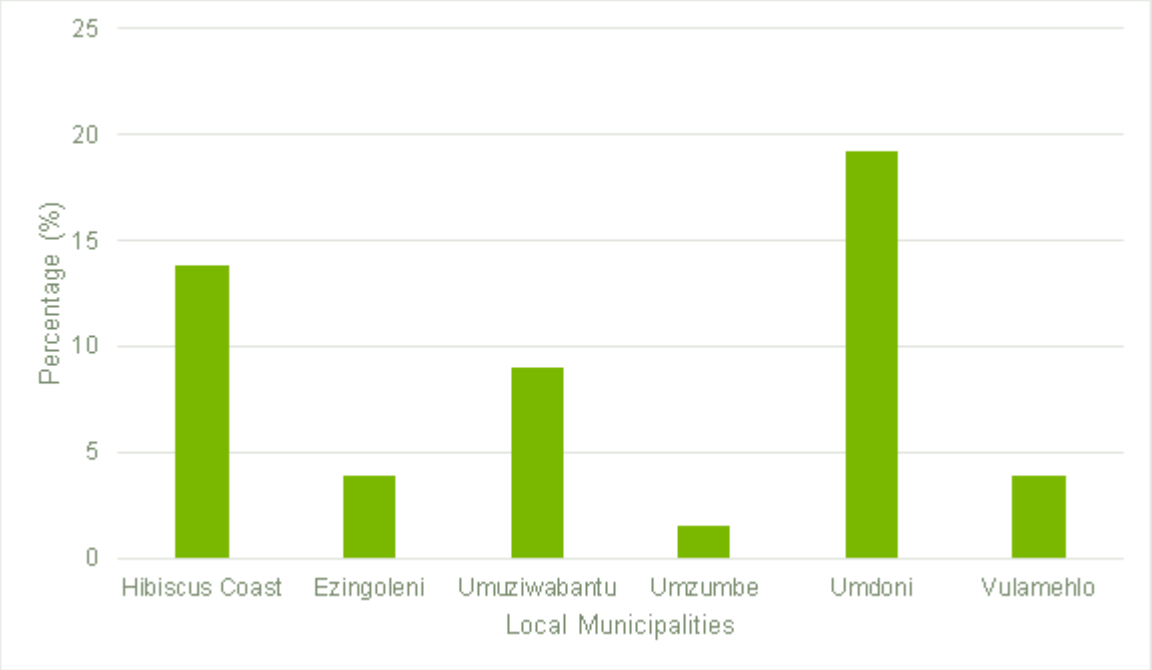


Figure 12: Ugu Manufacturing Sector breakdown

2.2.4 Tourism

Tourism is a key contributor to the District's economy and is guided by the Ugu South Coast Tourism Entity. The tourism sector and its potential is largely linked to the region's natural assets, mild climate and proximity to major centres. However, because the District is not fully exploiting its potential the tourism sector's growth is constrained. Currently, the tourism sector is driven by domestic tourists, with infrastructure and facilities related limitations being cited as possible reasons for a lack of international appeal. Environmental degradation related to climate change and weather-related hazards has been highlighted as a potential risk factor for the tourism industry.[31] Challenges in the tourism sector stem from poorly accessible roads, poor skills, uninviting tourism packages, lack of black empowerment transactions and not using land owned by the public sector.[32]



Green Economy

Climate change offers opportunities for growth of the green economy[33] which can be beneficial to Ugu as it provides solutions to environmental challenges and provides cost efficient water, energy and food to vulnerable people. A study conducted by the Industrial Development Corporation and Development Bank of Southern Africa predicted that the green economy will provide 100 000 jobs in the short term, 255 000 in the medium term and 462 000 in the long term.

KwaZulu Natal Department of Economic Development and Tourism is mandated to oversee development in the different sectors of the economy. The Department is guided by national policies and strategies including the Green Economy Framework and Strategy. Recently a report on unlocking the green economy was developed by the Department which identified priority areas for economic growth in KwaZulu Natal. These priority areas include supporting the Green Service Sector and the greening of:

- Tourism through ecotourism
- Food production by making use of no till agriculture
- Energy production using sugar cane waste as well as energy efficiency by utilising solar power, green buildings and public transport

[31] Ugu DM. 2012. Ugu District Growth and Development Strategy.

[32] Ugu District Municipality Annual Report 2013/2014: http://ugu.gov.za/Documents/Annual%20Reports/2013-2014/Annual-Report-2013-14.pdf

[33] Ugu Municipality District IDP, Annual Review 2015/16, pg. 12, http://ugu.gov.za/Documents/IDP/Ugu-District-Municipality-IDP-2015-16.pdf

- Water production by implementing rain water harvesting and grey water systems

The green economy is also predicted to grow with regards to resource efficiency, emissions mitigation, pollution control (using electric vehicles, cleaner stoves as well as capturing and storing carbon), natural resource management as well as ecosystem restoration and conservation. The growth of the green economy with regards to energy and emissions control results in opportunities for the private sector to utilise more efficient energy and water provision. Natural resource management and ecosystem conservation requires government investment. Thus, establishing public private partnerships provides further opportunities for the green economy to thrive in Ugu. Types of green economy projects funded in KwaZulu Natal thus far include wind farm projects and payment for ecosystem services.

2.3 Institutional Capacity

Climate change is relevant to a wide range of local government functions, and is another factor to take into account among the range of factors that local government already considers in all its decision-making. A municipal climate change response has been identified in the NCCRP for inclusion into IDP planning[34]. Accordingly the council will have to endorse the integration of climate change into the IDP process. The IDP office has to mandate a suitable line department to drive climate change considerations during the drafting of the IDP. On a district level this responsibility has been assigned to the Environmental and Health Management portfolio. According to national policy, the department tasked with driving climate change, will be responsible for the following;

- Appointing a 'champion' official to drive the climate change planning process;
- Gathering necessary information and liaising with other departments and institutions where necessary;
- Liaising with the IDP Office on integration of the process into IDP review timeframes;
- Participation on the IDP drafting team; and
- Establishing a steering committee from a cross sector of relevant departments to address the issues or participate in an existing committee that addresses similar issues.

Climate change considerations alone, are unlikely to compel local government action. The application of risk management procedures in assessing and prioritising possible responses to climate change effects will be required to effectively modify outcomes.

Some initial steps towards integrating climate change into planning processes includes policy and rules, and decision-making on specific consent applications. However, uncertainty remains about how and when to act on projected climate change risks and impacts. The following questions can assist local government in building response capacity:

- What are the potential climate change issues in the region, city or district?
- Has the council done a risk screening/assessment for a new development or project?
- What does the most recent scientific information show about likely climate changes in the district?
- Is more detailed risk analyses warranted?
- Is the council advocating action?
- Are other district councils within the region identifying issues or already taking action?
- What can you learn from them?
- What are the most appropriate methods to respond to risks?
- Some specific legislation?

Climate change risk assessment and decision-making does not take place in a vacuum, particularly within the local government context. The NCCRP emphasise the need for national and provincial government to support the implementation of climate change response. A mainstreaming approach will negate significant capital expenditure, but will require initial investment and financial support.

[34] DEA. 2011. National Climate Change Response White Paper.

Unfortunately, the current fiscal mechanism does not foster the integration of climate change response into local government actions.

2.3.1 Ugu District

District municipalities administer and make rules for a district, sharing the responsibility for local government with local municipalities in their area to facilitate equal access to resources and services, with specific reference to disadvantaged communities. The district municipality provides support to local municipalities who don't have the capacity to provide services to their communities.

Some of the functions and powers of district municipalities include:

- To plan for the development for the district municipality as a whole;
- Bulk supply of water that affects a large proportion of the municipalities in the district;
- Bulk supply of electricity that affects a large proportion of the municipalities in the district;
- Bulk sewerage purification works and main sewerage disposal;
- Waste disposal sites for the whole district municipal area;
- Municipal roads for the whole district municipal area;
- Regulating passenger transport services;
- Municipal health services for the whole area;
- Firefighting services for the whole area;
- Control of fresh produce markets;
- Promoting local tourism for the whole area; and
- Municipal public works.

District councils have a primary role in assisting local authorities through providing policy guidance, information and hazard assessment data. All of these functions and powers can be affected by or linked to climate change. However, the lack of clearly defined roles and responsibilities, a lack of capacity and resources, and a general lack of awareness have resulted in inadequate climate change management objectives and priority actions. As such, current climate change response management actions remains reactionary or response driven, and often uncoordinated within the Ugu District and local municipalities. Many of the local municipalities feel the responsibility should lie with the District assisted by a number of provincial and national organs of state.

2.3.2 Local Municipalities

Although some efforts have been made, the local municipalities of the Ugu District as a whole do not have clear co-ordinated objectives with regards to climate change response management. This can be attributed to the lack of climate change awareness within current institutional structures and the subsequent failure to acknowledge climate change response as a top priority.

Even though their functions and powers will certainly influence or be affected by climate change, climate change is not currently considered as a core function and none of the local municipalities have allocated funding specifically for climate change response. The majority of the local municipalities simply do not currently possess the institutional or financial resources to manage climate change issues effectively either separate of other functions or as part of their existing functions. This is illustrated by the fact that none of the local municipalities have an official climate change champion with clearly defined roles and responsibilities who is endorsed by the IDP office.

Subsequently, local municipalities will rely heavily on input from the Ugu District and provincial structures, to assist them in improving their resilience. From this reliance, the Ugu District has the opportunity to direct the climate change response and adaptation in a co-ordinated and priority centric manner in response to high vulnerability and coping capacity deficiency.

Table 3 Current Institutional Capacity for Climate Change Response

Municipality	Dedicated Environmental Officer	IDP Office endorsed Climate Change Champion	Unofficial Climate Change Champion	Climate Change Response included as component of IDP	Municipal Policy addressing climate change
Ugu District	Yes	No	Yes	Yes (limited)	No
Hibiscus Coast	Yes	No	No	No	No
Umzumbe	Yes	No		No	No
uMuziwabantu	In Progress	No		No	No
Vulamehlo	No	No		No	No
uMdoni	Yes	No		No	No
Izinqoleni	No	No		No	No

Where needed, local municipalities may formally request assistance from the Ugu District for climate change response management. If the Ugu District is unable to provide such assistance it may in turn request the assistance of the relevant provincial or national departments.

2.3.3 Potential Stakeholders

Climate change is everybody's business and Ugu District climate resilience can only be achieved through active participation of all relevant stakeholders. It is anticipated that many climate change response projects will be executed on a partnership level and in such cases the Ugu District and local municipalities should be in a position to harness private, public and academic sector networks in addressing climate change.

Stakeholder engagement seeks to create a broad platform for encouraging partnerships and constructive dialogue and action between stakeholders during the decision making process, policy development and/or implementation.

- **GHG emissions**

The Ugu Air Quality Management Plan articulates that greenhouse gases in Ugu are emitted through biomass burning, vehicles, residential activities and activities in the manufacturing sector. Municipal landfill sites are also associated with GHG emissions. Carbon monoxide is the pollutant emitted in the largest quantity. The second highest emissions are of nitrogen oxides followed by volatile organic compounds, carbon dioxide, particulate matter and sulphur dioxide. Benzene and lead emissions are very small in quantity.

Vehicles are the most common source of air pollutants in the Ugu district mostly emitting carbon monoxide which is a by-product of combustion. Other vehicular emissions include nitrogen oxides, volatile organic compounds, particulate matter and sulphur dioxide. Most emissions in Hibiscus Coast and Umdoni are derived from vehicles. The built up coastal corridor and the N2 runs through both local municipalities resulting in much more traffic in these local municipalities than in the others.

Most biomass burning occurring in Ugu includes burning of sugarcane and natural vegetation as well as arson fires. Carbon dioxide is the most emitted gas by biomass burning. The KwaZulu Natal Department of Agriculture and Environmental Affairs has developed a guideline for burning sugarcane in KwaZulu

Natal which is cognisant of guidelines and activities of climate change mitigation. According to remote sensing data obtained from the Merake Institute biomass burning mostly takes place in Umzumbe and uMuziwabantu Local Municipalities.

Sources of energy or fuel for domestic activities such as cooking, lighting and heating include electricity, gas, wood, coal, paraffin, animal dung and solar. Emissions from domestic activities are highest in Umzumbe Local Municipality followed by uMuziwabantu. This is because there are a large number of households that burn wood for cooking and heating. Emissions from domestic activities are low in Hibiscus Coast and Umdoni because very little wood is used as an energy source. The distribution of energy sources represents the urban bias in Ugu. Emissions released by domestic activities are mostly volatile organic compounds.

Manufacturing activities mostly take place in Hibiscus Coast which is the most industrialised local municipality in Ugu. Manufacturing activities also take place in uMuziwabantu and Umdoni but at a smaller scale than Hibiscus Coast. Emissions from manufacturing activities in Vulamehlo, Izinqoleni and Umzumbe local municipalities is negligible. Manufacturing mostly emits carbon monoxide followed by nitrogen oxides and particulate matter. A small amount of sulphur dioxide is released as well.

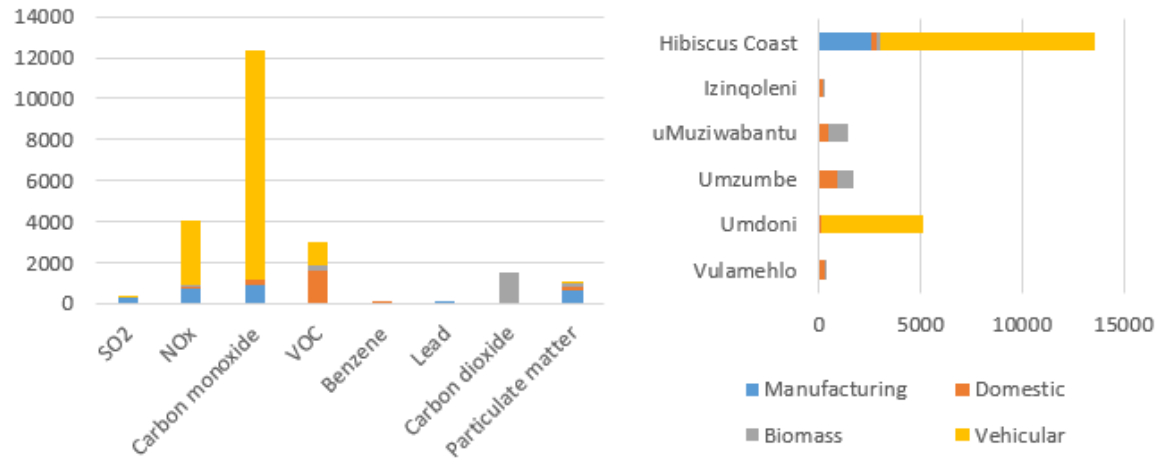


Figure 13: GHG assessment

2.3.3.1 Public Sector

Local government will rely on National and Provincial Government for support in addressing climate change. Climate change is a cross-cutting risk that will impact on the operations of all governmental departments and the entire administrative system, including parastatal entities. Effective vertical and horizontal coordination will be required to ensure climate change response is aligned with national policy and implemented effectively. Improved institutional capacity will play an important role in ensuring policy formulation adequately addresses climate change response. Existing skills must be consolidated and buy-in from different departments and spheres of government facilitated. This can be achieved by addressing climate change in a way that focusses on sustainable and effective service delivery. The development and emphasis of green buildings and providing for climate resilience in public sector infrastructure projects sets the example and places the public sector as a leading climate adaptation role model.

2.3.3.2 Private Sector

As contributors to carbon emissions but also to private sector funding and climate change response actions, business and industry are important stakeholders in building climate resilience. Partnerships between local government and the private sector will be critical for the Ugu District transition towards climate resilience. Furthermore, as the private sector has a vested interested in development and industry, it is exposed to the risks associated with climate changes, i.e. agricultural sector, droughts,

flooding, health, etc. For instance, failure to adapt and plan in the insurance sector will render significant financial losses for the industry. It is therefore in the best interests of private sector businesses to champion climate mitigation and adaptation implementation in adherence to the climate change response strategy.

The Ugu District Municipality has an Air Quality Management Plan (AQMP) that states that the municipality's Environmental Services acts as the Atmospheric Emission Licensing Authority. Atmospheric Emissions Licenses (AEL) must be obtained by anyone carrying out activities listed under the National Environmental Management Air Quality Act 39 of 2004. This ensures that air quality is not harmful to health and wellbeing by regulating point source emissions and ambient air quality. The District's AEL Authority mitigates emissions through good governance and engagement with stakeholders such as the private sector to meet the air quality objectives set out in the IDP.

2.3.3.3 Civil Society

Civil Society has the important responsibility to critically evaluate public and private sector initiatives in their effectiveness to meet climate resilience criteria. Civil society along with local government should continue to raise awareness and hold individuals, institutions and authorities accountable for climate change mitigation and adaptation or the lack thereof. Civil society can also act independently on smaller scales to increase climate resilience through sustainable no-regret projects, rather than relying on government or institutional intervention. Examples include implementation of crop rotation and intercropping, domestic greywater re-use, small scale afforestation or sustainable fishing practices. Any implemented actions should align with the climate change response strategy objectives.

NGO's and NPO's can mediate the interaction between civil society and local governments by channelling engagement between them. An example of an NGO that takes on this responsibility is OneWorld which has an integrated and cooperative approach to dealing with climate change issues by forming stakeholder partnerships. An example of channelled engagement in KwaZulu-Natal is when Ground Work, a non-profit organisation joined with communities in November 2013 to set up a people's climate camp to debate climate and energy justice and emphasise the resistance of people to dirty energy and destructive development.

2.3.3.4 Non-governmental response

Academic institutions are in a position to increase community resilience by providing the science and research necessary to inform public policy. Establishing partnerships with local academic institutions, to allow for the generation of locally relevant climate change information, will contribute to improve the Ugu District's capacity to address climate change.

In November 2013, communities joined with Ground Work to set up a people's climate camp in south Durban to debate climate and energy justice and emphasise the resistance of people to dirty energy and destructive development. In the Ugu District, IKUSASA Sustainable Community Development embarked on a climate change dialogue for the Ugu district traditional councils to assist communities that are affected by climate change. The dialogue specifically states that climate change is a threat to food security so the aim is therefore to ensure food security and protect the environment while addressing agricultural, land use and climate change issues. IKUSASA is working with the University of KwaZulu Natal to reduce the impact of these issues on rural communities.

The University of Cape Town has set up initiatives such as the African Climate & Development Initiative (ACDI) and the Climate System Analysis Group (CSAG). CSAG has done research throughout South Africa involving atmospheric science, climate modelling and applied climate analysis. CSAG also focuses on applying climate data by researching climate change impacts, adaptation and vulnerability. ACDI focuses on consolidating and coordinating climate change research on mitigation, vulnerability, impacts and adaptation, climate science and sustainable development.

Research institutions increase scientific knowledge on climate change which assists with understanding, educating new generations and creating awareness of climate change. Amongst other research areas,

the Council for Scientific and Industrial Research (CSIR) has units committed to research in natural resources and the environment which focuses on climate change adaptation and mitigation, ecosystem services and water resources. These units also discover environmental solutions for a green economy. The CSIR has done a vast amount of research on climate change in KwaZulu-Natal which covers topics on technology, climate resilient infrastructure, coastal zones, water resources, ecosystems, sand mining, air quality and health. South African National Biodiversity Institute (SANBI) conducts and coordinates research and monitoring on the state of South Africa's biodiversity that is placed under threat by issues such as climate change. SANBI also provides knowledge and advice on policies and best-practice management. SANBI assisted in compiling the LTAS reports.

NGOs that have contributed to climate change response throughout South Africa include:

- Food and Trees for Africa
- OXFAM
- Ground Work
- South Durban Community Environmental Alliance
- Environmental Monitoring Group
- IDEX partners such as Biowatch, Surplus People Project, Whole World Women Association, Positive Women's Network and Ubunye Foundation

2.4 Service Delivery

Service delivery is often the primary means for local government to build resilience among communities within their constituencies. As such it is paramount in determining the community exposure and manageability to general hazards as well as those associated with climate changes and altered meteorological means states as well as institutional coping capacity. Ugu DM has noted its importance and embraced the back to basics approach to ensure effective service delivery, efficient administration and clean governance

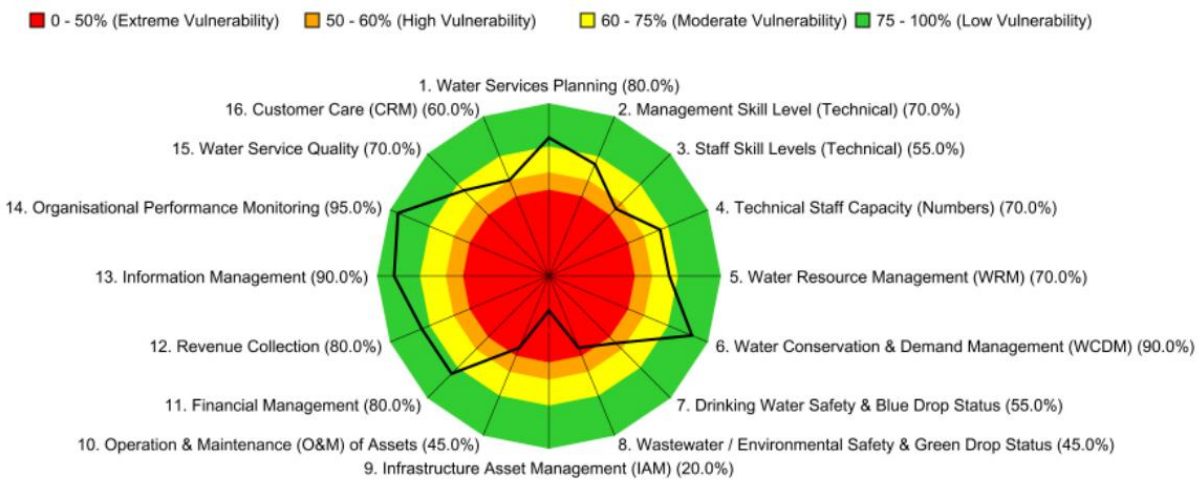
The back to basics program seeks the following objectives[35]

- Put the people and their concerns first and to ensure constant contact with communities through effective public participation platforms.
- Create conditions for decent living by consistently delivering municipal services to the right quality and standards.
- Be well governed and demonstrate good governance and administration by cutting wastage, spending public monies prudently, hiring competent staff, ensuring transparency and accountability.
- Ensure sound financial management and accounting and prudently manage resources so as to sustainably deliver services and bring development to communities.
- Build and maintain sound institutional and administrative capabilities, administered and managed by dedicated and skilled personnel at all levels.

Ugu DM has done the municipal self-assessment in order to benchmark compliance and progress relative to the back to basics program.

[35] Department of Co-operative Governance and Traditional Affairs (COGTA), http://www.kzncogta.gov.za/

Municipal Strategic Self-Assessment (MuSSA) of Water Services (2014/2015)[36]



Back 2 Basics Categorisation	MuSSA Vulnerability
Not Doing Well	High Vulnerability
Putting People First	Water Service Quality
	Customer Care (CRM)
Basic Service Delivery	Water Services Planning
	Water Resource Management (WRM)
	Water Conservation & Demand Management (WCDM)
	Drinking Water Safety & Blue Drop Status
	Sanitation (to be part of future assessment)
	Wastewater/Environmental Safety & Green Drop Status
	Infrastructure Asset Management (IAM)
	Operation & Maintenance of Assets
Good Governance	Information Management
	Organisational Performance Monitoring
Sound Financial Management	Financial Management
	Revenue Collection
	Financial Asset Management (to be part of future assessment)
Building Capable Local Government Institutions	Management Skill Level (Technical)
	Staff Skill Levels (Technical)
	Technical Staff Capacity (Numbers)

Extreme Vulnerability	High Vulnerability
Moderate Vulnerability	Low Vulnerability

The conclusion is that Ugu DM in general is “not doing well” and that there is a high vulnerability in the district. Areas of concern contributing to this negative rating are in the basic service delivery category being wastewater and environmental safety and green drop status, infrastructure assess management and asset operation and maintenance, there is also high vulnerability in the drinking water safety and blue drop status. Organisationally, Ugu DM scores well with a majority of Low and moderate vulnerability scores in the categories of good governance, financial management and putting people first. Building capable local government institutions will need further skill development among the staff members to better capacitate institutional resilience.

[36] Ugu DM Back to Basics (B2B) water and sanitation vulnerability status, www.dwa.gov.za

The identification of service delivery shortfalls will inform development priorities. Sanitation and electricity services have a significant majority that meet the minimum standard among households; water services has a less comprehensive majority above the minimum standard, while waste management is severely lagging in the deployment of minimum standards to households. These services are expanded further below.

SERVICE BACKLOGS AS AT 30 JUNE YEAR 2013/14				
	Service level above minimum standard		Service level below minimum standard	
	No. of Households	% Households	No. of Households	% Households
Water	103297	57	77927	43
Sanitation	144979	80	36245	20
Electricity	155852	87	25372	13
Waste management	28995	16	152229	84

2.4.1 Water

Ugu mostly obtains water from river runoff but also from groundwater, dams and bulk water purchases from eThekwini and Umgeni. As a result of Ugu's reliance on river runoff as a main source of bulk water Ugu is susceptible to water shortages. The District Municipality is a water service authority (WSA) and is therefore responsible for providing access to basic infrastructure and services to provide drinking water of good quality. The District has five main catchment areas: The Mlazi and Lovu catchments; the Mkomazi catchment, the South Coast catchment (Mzumbe, Mtwalume and Mpambanyoni Rivers), the Mtamvuma catchment and the Umzimkulu catchment. Bhobhoyi and Umtamvuna Supply Zones supply water to the formal urban strip. Rural areas are supplied by stand-alone water schemes. Umgeni Water supplies the District with bulk water in the northern areas and operates the Umzinto and Umthwalume Water Works. The ability of the municipality to accomplish its water services obligations relies heavily on the Mzimkhulu and Mtamvuma Rivers as they supply water to the Lower South Coast. In the 2013/2014 year the District had 9 837 657 cubic meters of unaccountable water losses[14].

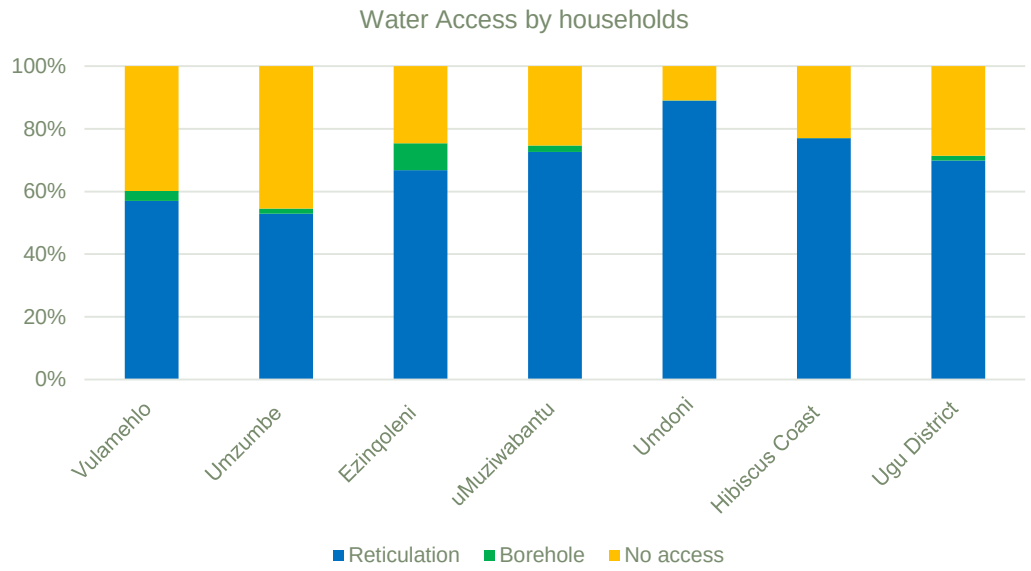


Figure 14: Municipal water access[37], Household water access minimum standards over time

Municipalities with the highest proportion access to reticulated water supply are Umdoni and Hibiscus Coast, with Ezinqoleni having the highest dependence on borehole water. The most exposed municipalities are those without access to water with Umzumbe and Vulamehlo being the most vulnerable. It should be noted that over time, there has been an increase in the delivery of water services that meet the minimum level or above (Piped water inside dwelling, Piped water inside yard, access to a public tap < 200m from household). This has changed from 66% of households in 2010/2011 to 71% in 2013/2014.

The 2012 Blue Drop report ranked Ugu's Blue Drop Performance at 6th place in KwaZulu Natal with a score of 92.55%. As the minimum score needed to obtain Blue Drop status is 95%, the District has achieved Blue Drop Awards for the Umthwalume, Umzinto and Umthamvuna systems with 96.27%, 95.22% and 95%, respectively. Umgeni Water contributed significantly to Ugu's ability to achieve and maintain Blue Drop Status in the Umzinto and Umthwalume Water Works. Although Ugu has achieved Blue Drop Status in the past, compliance monitoring was not adequate. Thus, the 2011 Blue Drop report states that drinking water will not be given the status of excellent chemical quality unless there is proof that monitoring is representative of all the risks associated with the supply systems. There is also a need for a full SANS 241 analyses to analyse Ugu's water quality determinants[38].

Sufficient water for both household and agricultural use is necessary in order to facilitate sustainable livelihoods. A future demand assessment undertaken during the Infrastructure Audit clearly shows that future water demand is greater than the current infrastructure capacity of the district. Accordingly, water resource management is a key priority for the District and impact of climate change on the district's water resources must be addressed. Estimates indicates that the municipality will need to at least double its current infrastructural capacity to meet water supply demands. This will require the implementation of innovative and sustainable solutions such as water conservation, demand management, rainwater harvesting, re-use of waste water and desalination.

[37] Ugu District Growth and development strategy, 2012
[38] Ugu Case Study, The water Dialogues, Raab, E

The municipality has however tried to address the infrastructural challenges by incorporating numerous upgrades into the 2014/2015 financial year. These upgrades include refurbishing the Vulamehlo Weza and Bhobhoyi Water Treatment Works, replacing 25km of water pipelines, the Murchison Upgrade Project (which includes the upgrade of a 10ML storage reservoir and a pump station) and a few other projects. The percentage of dwellings that have water available within 200m from them have increased from 66% in 2010/2011 to 75% in 2013/2014. Despite droughts the municipality still aims to render water services to communities. By the end of the 2015 financial year, the municipality planned to use R10.8 million for drought relief. However, a balance must be achieved between extending water services to all and the need to conserve resources.

2.4.2 Sanitation

Sanitation infrastructure backlogs are widespread especially in rural areas. Umzumbe Local Municipality is experiencing a sanitation backlog of 74% and Vulamehlo and Umuziwabantu Local Municipalities both have a sanitation backlog of 50%. Overall, Ugu has a sanitation backlog of 48%. Approximately 18% of households use flush toilets connected to a sewerage system, 7% have flush toilets with a septic tank, 9% have a chemical toilet, 18% have a pit toilet with ventilation, 34% have a pit toilet without ventilation, 2% have a bucket toilet, 7% have other modes of waste disposal and 5% of households have no sanitation facilities. Residents have been allowed to construct septic tanks in wetlands which has resulted in a lot of pollution[36].

In order to obtain a Green Drop Award a score of 90% is needed. Unfortunately, the municipality only achieved 73.91% in 2013. The Red Desert Waste Water Treatment Works however was awarded a Green Drop Award with a score of 90.3% in 2013. Green drop status has generally increased over time from the 2009 assessment with particular strengths being the bylaws. Of particular concern however is the constancy of the low scores presented by the waste water quality compliance. Ten of Ugu's wastewater treatment plants are categorized as low risk, nine are medium risk and the Murchison Hospital plant is categorized as a critical risk. The poor scores are attributed to poor effluent compliance but Ugu has identified the problems and implemented interventions. Providing access to decent sanitation is part of Ugu's mission. Therefore, Ugu has an urban and rural backlog eradication plan to provide adequate sanitation to formal townships and to conduct an audit of rural sanitation. The percentage of households with at least a ventilated improved pit latrine increased from 52% in 2010/2011 to 70% in 2013/2014. This shows that sanitation backlogs in Ugu are at least improving.

2.4.3 Electricity

Eskom is the sole provider of electricity in Ugu (except in Port Shepstone and Harding) and the delivery of electricity depends on the amount of National Treasury MTEF funding available. In general the district is well supplied in terms of electricity. Remaining backlogs to electricity provision is mainly caused by the lack of bulk infrastructure however regional projects have been identified to improve the electricity network and address backlogs. The percentage of households with access to electricity in the six different local municipalities at the time of the 2011 census are as follows:

- 85% of households in the Hibiscus Coast Local Municipality
- 80% of households in the Izinqoleni Local Municipality
- 80% of households in the uMuziwabantu Local Municipality
- 49% of households in the Umzumbe Local Municipality
- 37% of households in the Vulamehlo Local Municipality
- 37% of households in the Umdoni Local Municipality

The proportion of households in Ugu with the minimum level of basic services has steadily increased since 2010/2011. In 2010/2011, 72% of households had electricity service connections which increased to 85% in 2013/2014. The map below shows the location in which the regional projects are being implemented in order to improve the capacity of electricity networks and address backlogs. The map

also shows that most of the networks along the coastline are not constrained whereas networks in most of Umzumbe and Vulamehlo are constrained. The names of the projects that are being implemented are as follows:

1. Oslo SS 132/11 kV 20 MVA Establish
2. Munster 88/22/11 kV SS
3. Marina SS 88/22 kV 7 88/11 kV transformer Upgrade
4. Zwelethu 132/22 kV 2 x 20 MVA SS
5. Ramsgate Substation upgrade
6. Pont - Port Edward 132 kV cable
7. Umgababa 132/22/11 kV SS est.
8. Sezela Substation Upgrade
9. Pungashe NB41 upgrade - to be supplied from Kenterton. Via a proposed 2.5 22/11 Mobile
10. Widenham 88/11 kV 20 MVA establishment

Map: Capacity of electricity networks in the Ugu District

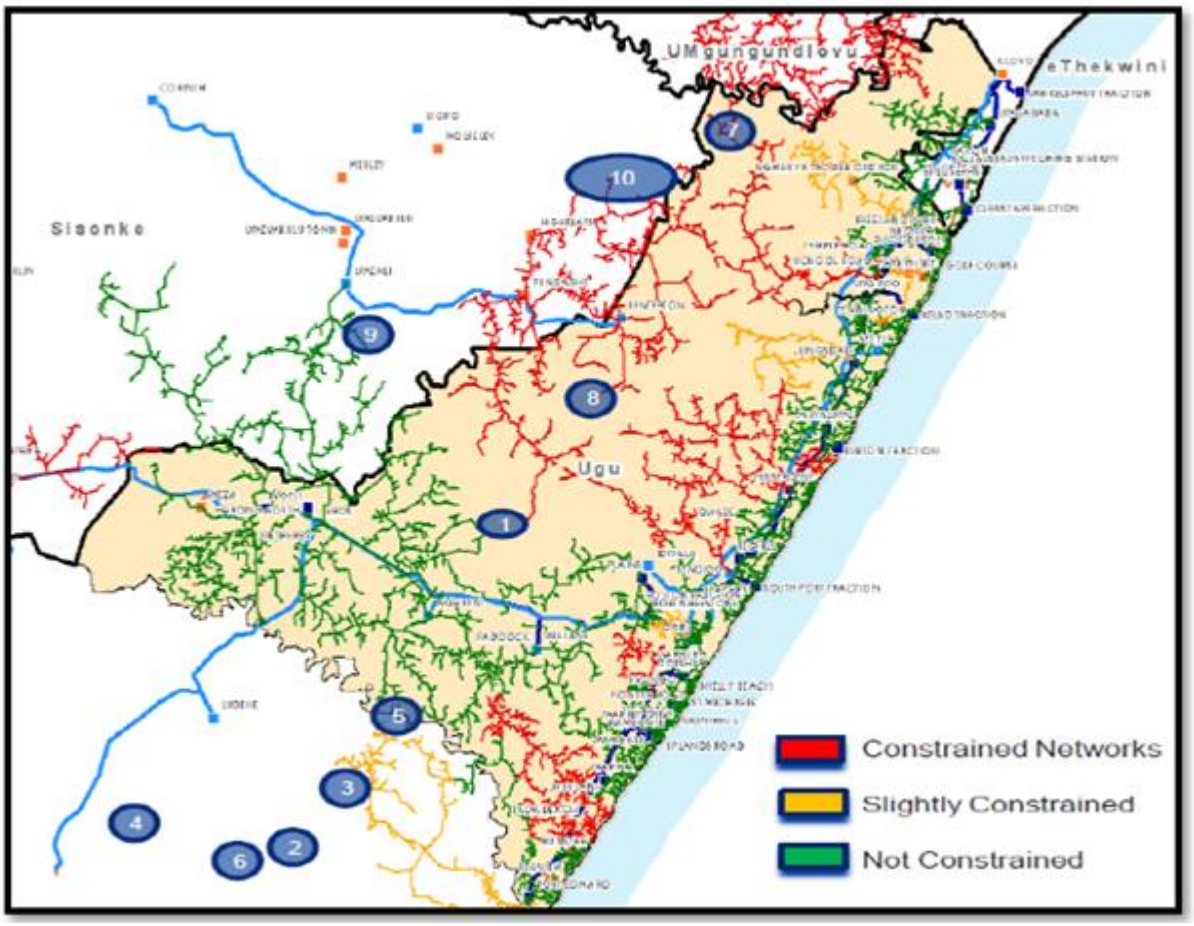


Figure 15: Capacity of electricity networks in the Ugu District[39]

2.4.4 Waste services

Waste services, as mandated though the National Environmental Management: Waste Act (Act 59 of 2008) places the responsibility of solid waste collection and processing on the municipality. These services are by enlarge only available in the formalised urban centres of Umuziwabantu, Hibiscus Coast and Umdoni Municipalities with access by 11%, 45% and 42% of households respectively. Households in Umzumbe, Ezingoleni and Vulamehlo have only 2%, 2% and 3% access respectively. Less than 40% of the households in Ugu have waste removal services. The remaining households in Ugu DM have to

[39] Ugu IDP 2015/2016

resort to use communal refuse dumps (~1%), personal/own refuse dumps (~66%) or no rubbish disposal at all (~6%). The integrated waste management plan and the infrastructure audit (phase 3) highlighted waste services as the most under-delivered service in the district.

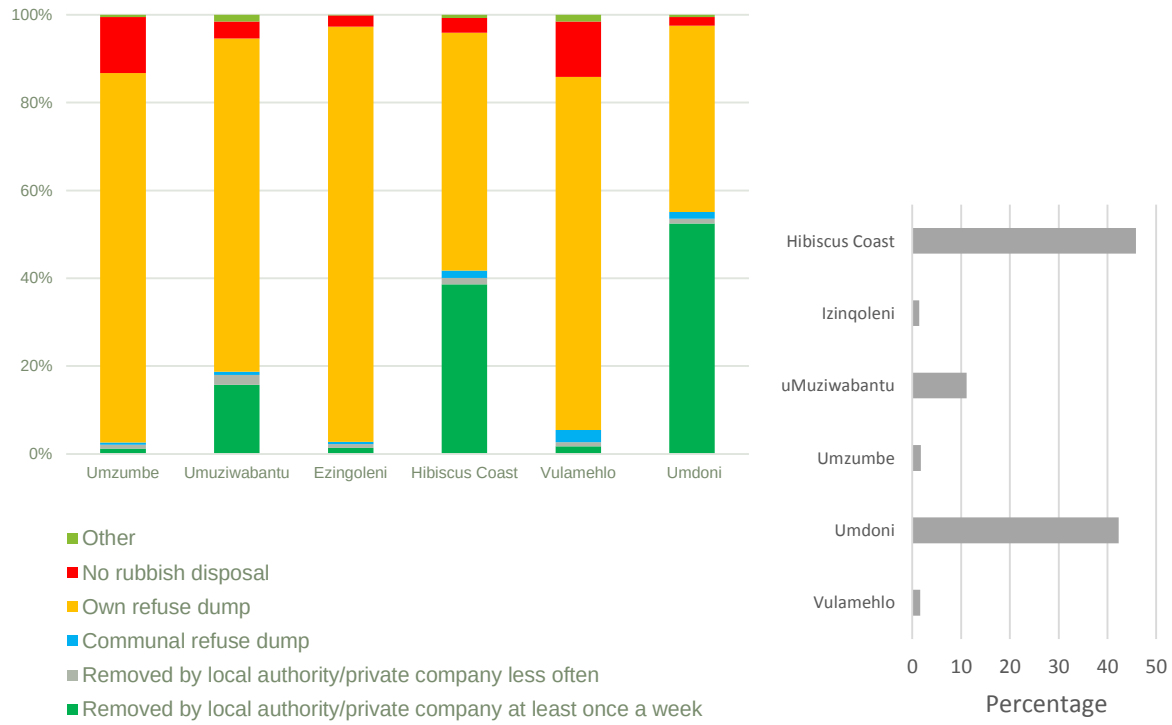
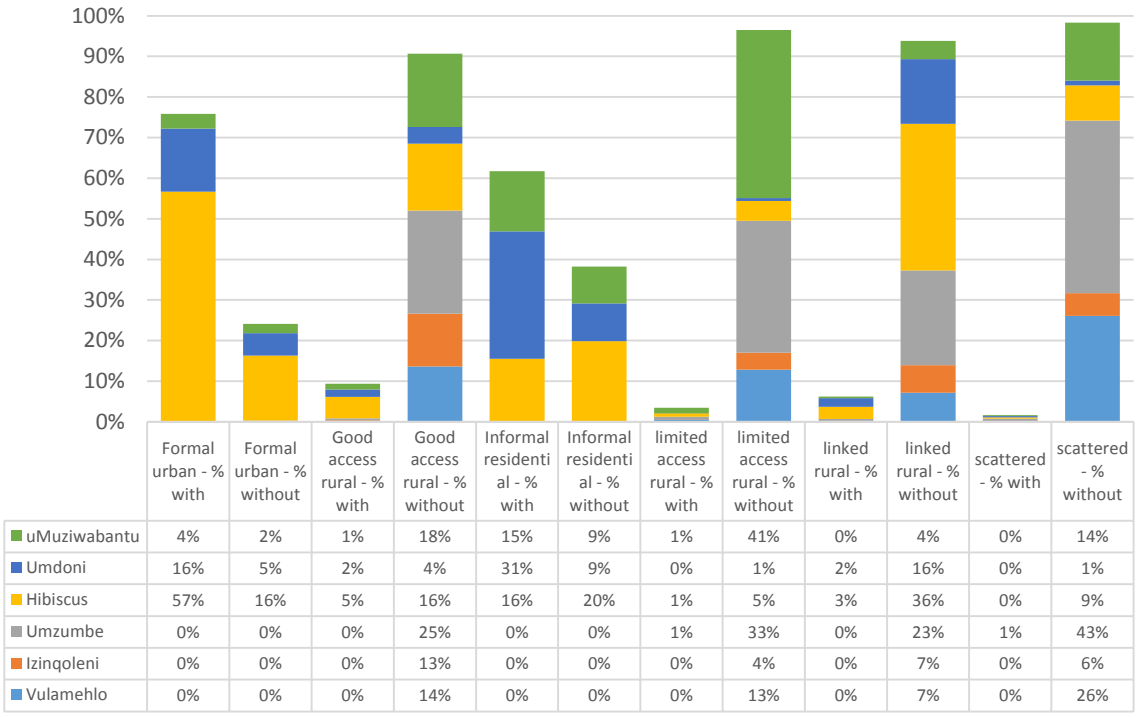


Figure 16: Type of waste services

Almost 80% of formal urban areas receive waste services, especially in Hibiscus Coast, Umdoni and uMuziwabantu. Approximately 10% of good access rural settlements and linked rural settlements receive waste services. Less than 5% of scattered settlements, informal residential settlements and limited access rural settlements receive waste services. The graph below shows that waste removal services are biased towards formal settlements in urban areas such as Hibiscus Coast because only ~20% of these areas are underserviced, compared to most (>90%) rural areas and scattered settlements such as those in Umzumbe, uMuziwabantu and Vulamehlo. Although many informal settlements (about 40%) receive no waste removal services it is important to note that more than half (~60%) of these areas are serviced.



	Formal urban - % with	Formal urban - % without	Good access rural - % with	Good access rural - % without	Informal residential - % with	Informal residential - % without	limited access rural - % with	limited access rural - % without	linked rural - % with	linked rural - % without	scattered - % with	scattered - % without
uMuziwabantu	4%	2%	1%	18%	15%	9%	1%	41%	0%	4%	0%	14%
Umdoni	16%	5%	2%	4%	31%	9%	0%	1%	2%	16%	0%	1%
Hibiscus	57%	16%	5%	16%	16%	20%	1%	5%	3%	36%	0%	9%
Umzumbe	0%	0%	0%	25%	0%	0%	1%	33%	0%	23%	1%	43%
Izinqoleni	0%	0%	0%	13%	0%	0%	0%	4%	0%	7%	0%	6%
Vulamehlo	0%	0%	0%	14%	0%	0%	0%	13%	0%	7%	0%	26%

Figure 17: Percentage of Settlement types in each local municipality with and without waste removal services

Generation of waste varies by income and settlement type, with wealthier people in urban areas generating more waste than lower income people and rural areas. This is evident in Hibiscus Coast and Izinqoleni where consumers generate approximately 200 and 5.7 tons of waste per day, respectively. Figure 18 shows the type and amount of waste generated per local municipality. Vulamehlo, Izinqoleni and Umzumbe do not have waste disposal sites and so it is difficult to determine the type of waste generated in these local municipalities. Hibiscus Coast and Umdoni generate the highest volumes of waste categorised as other and organic respectively and uMuziwabantu generates the highest volumes of paper waste. Of all the waste generated in Ugu only 46% is accounted for at landfill sites, the remaining 54% may be buried, illegally dumped or burned and so never reaches the landfill sites. Only 76% and 90% of waste generated in Hibiscus Coast and Umdoni is disposed of formally meaning that the remaining 24% and 10% is either buried or illegally dumped.

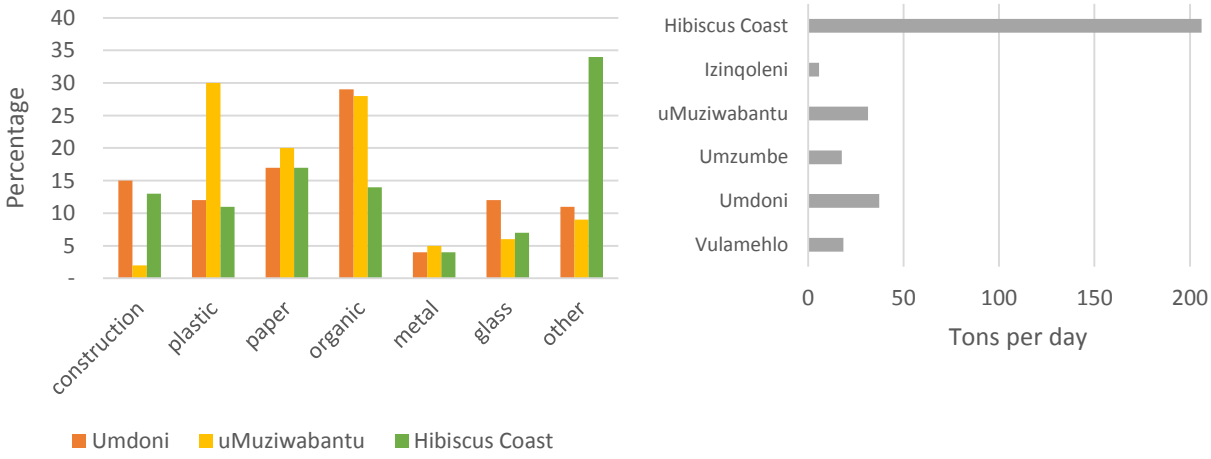


Figure 18: Waste generation per local municipality

In order to achieve the objectives of the Integrated Waste Management Plan Ugu currently has waste management interventions in place which include recycling programmes and education/awareness on waste management. However, the district has no integrated system in place to assist private recyclers because the viability of recycling requires enough recyclable material to justify the cost of collection. Thus, more work needs to be done before a recycling system that is economically viable can be put in place in Ugu. Some of the local municipalities have no designated waste officials and as a result have limited waste management[40].[1] Umdoni Local Municipality renders kerbside domestic refuse collection services in residential areas once a week (Monday to Friday in uMuziwabantu) and cleans street. Umdoni also removes waste in central business districts 6 days per week (Hibiscus coast does this daily and uMuziwabantu does this twice during work days and once a day on weekends). Street sweeping takes place is Hibiscus Coast, uMuziwabantu and Umdoni and Hibiscus Coast renders refuse collection services within the coastal belt from Monday to Friday.

2.4.5 Road Infrastructure

Having access to road networks will allow local populations the opportunity to use private or public transport to expand their range. They my use the road network to commute to work, sell produce to passers-by, travel to medical facilities and for social purposes among others. Communities and households that are in proximity to a road network have therefore a decreased exposure to the impacts of hazards but also have the ability to better their personal economic standing and resilience.

The coastal municipalities of Hibiscus Coast and Umdoni have the highest proportion of households within 1km of road networks at 97% and 95% respectively, thus further demonstrating the dual nature of the district.

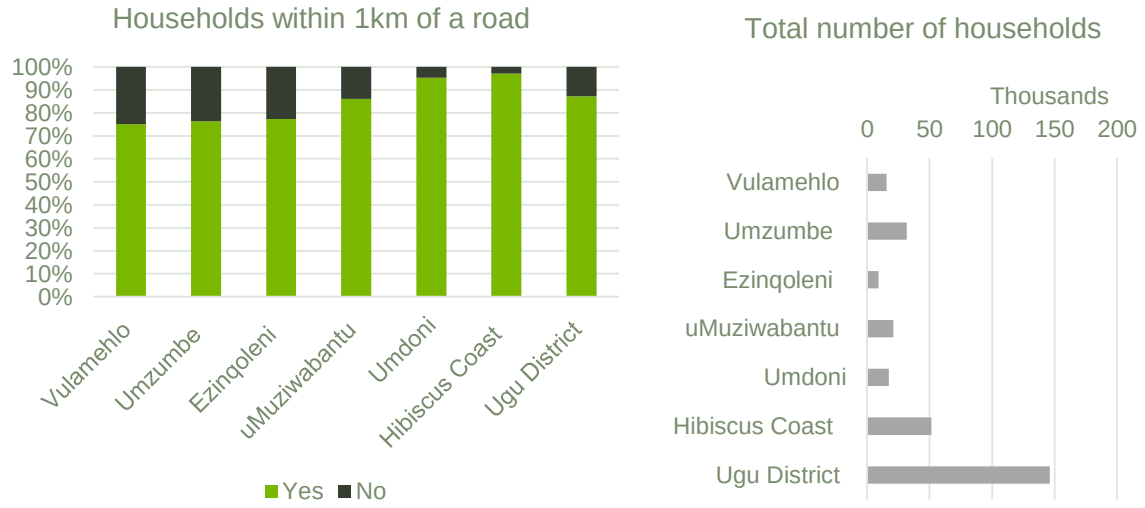


Figure 19: Household access to road network[41]

The provincial road network provides a high proportion of the road network in Ugu, Networks of local roads constructed and maintained by the six local municipalities exist in urban areas, but funding for the construction of new roads is limited. Local roads within the more urban centres are constructed and maintained by local municipalities. Rural municipalities are heavily reliant on the provincial Department of transport for budget.

Existing road infrastructure is generally poorly maintained. Issues have been identified regarding the poor condition of roads servicing large populations, which may be exacerbated by projected climate

[40] Ugu IDP

[41] Ugu District Growth and development strategy, 2012

changes. These poor road conditions will negatively impact of travel speed and safety and reduce business settlement desirability. Upgrade potential has however been targeted in the rural areas and along specific agricultural routes. Alignment with national and provincial upgrade priorities remains a key strategy for empowering the communities within Ugu DM.

2.4.6 Health

About 75 structures exist in the District for primary health care. These structures include mobile clinics, clinics, community health centres, district hospitals, regional hospitals and one specialised TB hospital. There are some communities that do not have access to these primary health care structures.

HIV/Aids and TB is widespread throughout the District with the Hibiscus Coast Local Municipality having the highest number of HIV positive people. The total number of HIV positive people changed from 23462 in 1995 to 114987 in 2011 accounting for approximately 5.5% year on year continuously for 16 years. This increase is a major cause for concern, enhancing pressure on existing health facilities and resources as well as the subsequent increase in child-headed households, higher dependency levels, vulnerability to external impacts, lowered productivity potential through a depleted labour force, and ultimately deepening poverty.

The high rates of disease such as HIV/Aids and TB increase the population's vulnerability to additional stressors such as increased temperatures and occurrence of vector borne diseases such as malaria. It is highly like that projected climate change impacts will place additional pressure on the health status of the district's population and subsequently the region's health services.

2.5 Vulnerability status

Climate changes will alter the frequency and intensity of extreme meteorological events. Being exposed and susceptible to the impacts of these events either though proximity to a flood zone, population density or through building material type for example brings about a level of vulnerability. However, climate change will also alter the normal day to day weather experienced in the area. These changes will expose the people and the environment to weather outside of the normal ranges. The degree to which these changes affect your health, safety, wellbeing and livelihoods is the measure of exposure of vulnerability to the hazard caused though climate change. Factors influencing this exposure may be personal income/employment or education acting as a proxy for populations to adapt to changes over timer time frames.

In the context of uneven resource distribution, variable institutional capacity, compromising environmental systems and the importance of agriculture, tourism and manufacturing to livelihoods and economic stability, the Ugu District Municipality has significant vulnerability to the potential impacts posed by a changing climate. However, the district goals of sustainable and equitable service provision and providing a safe and healthy environment for all provides the platform for mainstreaming adaptive, climate resilient development. Climate resilience should be implemented into day to day institutional operations of basic service delivery as well as when considering long term human settlement planning, urban development, municipal infrastructure, water and energy demand management and local disaster management. Adaptation to the present and likely future impacts of climate change, is a key opportunity to meet the district development goals.

General vulnerabilities identified bases on the initial situational analysis are:

- Changes and impacts to water resources;
- Agricultural sustainability and food security;
- Biodiversity, ecosystems and sensitive natural environments
- Impacts on storm water infrastructure and other infrastructure located in areas of flood potential;

- Impacts on human health due to extreme temperature and prevalence / occurrence of vector borne diseases;
- Impacts on the transportation sector and infrastructure.
- Energy utilisation and potential impacts on electricity infrastructure;

Vulnerability to climate changes is expanded further in Chapter 4

The following table describes the potential effects climate change impacts may have on certain functions of local government.

ASSETS/SERVICE DELIVERY	POTENTIAL CLIMATE CHANGE IMPACTS
Planning and Economic Development	
• Planning	• Uncertainty over long-term land-use planning and infrastructure design; • Needs and costs for retrofitting; • Loss/destruction of private property and community assets; • Increased insurance costs; • Increased pressure on risk management and response resources; • Untimely decommissioning of infrastructure; • Adverse impacts on public safety and tourism, could impact regional economic performance; • Impacts on existing community structures and livelihoods • Required alteration to development plans, risk assessment procedures and zoning; and • Increased pressure on educational resources to facilitate adaptation.
• Economic Development	• Impacts on local economy and food security due to impacts on agriculture and water supply; • Increased insurance costs; • Increase in food prices; • Losses incurred by industries directly dependent on agricultural production (e.g. fertiliser manufacturers); • Reduced tax revenues because of potential reduced expenditures; • Increased maintenance cost for community and private assets; • Economic consequences of impacts on the Tourism Sector; • Business closure and potential for job losses due to interruptions resulting from water shortages, inundation, flooding, blackouts, etc.; • Altered agricultural regimes and practices, such as crop diversification due to reduced water availability of heat stress; and • Climate change impacts may cause alteration of traditional sources of rural revenue.

2.5.1 Vulnerability in Energy Sector

Energy	
• Demand	• Increased energy demand related to heating and cooling.
• Infrastructure	• Damage to distribution infrastructure due to extreme weather events and veldfires.
• Mitigation	• Potential impacts of climate variations on renewable energy production will alter practically of differing technologies.

Figure 20 shows that electricity is the most common type of energy used in Ugu and that alternative energy is minimally used. After electricity wood is the most used energy for cooking and heating whilst candles are used for lighting. Very little renewable energy such as solar energy is used in Ugu. However Ugu DM has taken steps to promote its use by offering sustainable solar energy packages to scattered rural communities to improve the service delivery backlogs. In order for the green economy to grow the KwaZulu Natal Department of Economic Development and Tourism is promoting green energy production from sugar cane which may cause a shift in the types of energy sources used in Ugu.

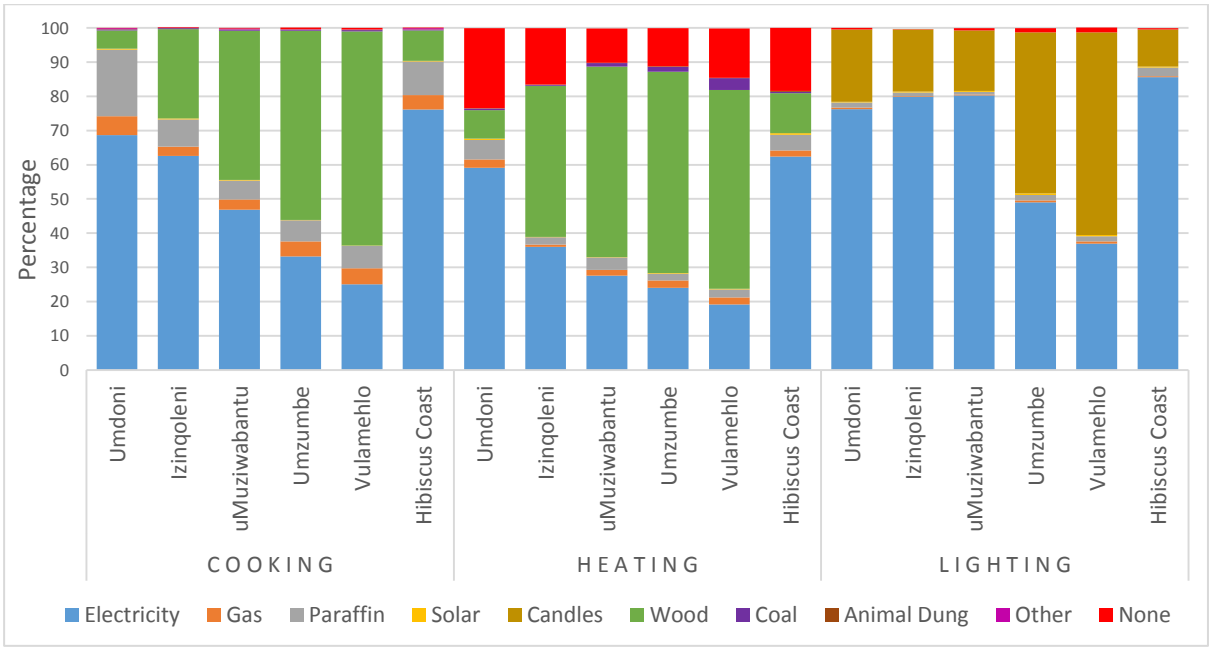


Figure 20: Sources of energy for cooking, heating and lighting per local municipality[42]

Municipalities in South Africa spent R87.5 billion on electricity in the June 2016 quarter which is 21.9% more than they spent in the March 2016 quarter. This increase can be linked to increased demand for electricity during winter months as well as Eskom's tariff increases. With increasing temperatures municipality expenditure may shift as demand for electricity for cooling increases in summer months and demand for heating in winter months decreases.

[42] Statistics SA, Census 2011

2.5.2 Vulnerability in Municipal Infrastructure

Infrastructure	
• Roads	• Changes in rates of deterioration of municipal road infrastructure due to changes in precipitation and temperature; • Inundation of roads in during intensified rainfall events, resulting in deterioration or destruction; and • Interruption of road traffic and disruption of emergency transport routes due to extreme climatic events.
• Storm water systems	• Increased erosion and inundation; • Loss of private property and community assets; • Loss of beach width; and • Changes to wetland and estuary ecosystems due to sea level rise, erosion and saline intrusion.
• Coastal Infrastructure	• Increased coastal erosion and inundation; • Increased or permanent inundation of infrastructure and utilities; • Impacts on private and public harbours and boat ramps; and • Increased erosion or deterioration of coastal defences.
• Buildings	• Altered cooling cost; • Increased risk of damage from fires or extreme hydro-meteorological events; and • Higher rates of deterioration and increased maintenance costs.
• Recreational Facilities/Community Assets	• Loss of public property due to inundation/flooding; • Impacts on tourism along due to changes in biodiversity, water availability; • Increased operating cost and maintenance of public property due to extreme weather events; • Reduced water quality and quantity for irrigation; and • Potential for closures due to extreme weather and/ or pollution levels.
• Coastal Management	• Increased intensity of precipitation may cause intrusion into waste water networks; • Capacity of existing flood defences and drainage systems may be exceeded; • Changes in mean and peak flow rates of rivers; and • Reduced precipitation may have negative impacts on functioning of storm water systems.

Infrastructure is a cross-cutting issues which involves various sectors. The District's growth and development depends on infrastructure such water and sewage systems, roads, bridges, and power distribution networks, much of which are aging and in need of repair or replacement. These issues will be compounded by rising sea levels, heat waves, and extreme weather events associated with projected climate change, stressing or even overwhelming essential services.

The climate changes projected for Ugu is expected to have significant implications for the cost, design standards and location of new infrastructure projects, as critical infrastructure designed for historical conditions become compromised or redundant. It is very likely that national government will need to support local government not only through clear policy guidelines, but also financial assistance. Key factors include:

- As extreme events are likely to become more frequent reliability standards and design thresholds will be required to increase accordingly;
- Potential shifts in rainfall patterns and migration is expected to alter the demand for infrastructure;
- Climate change may alter the optimal standards and technologies required over the lifetime of long term infrastructure projects.

Due to the uncertainties associated with climate change, the main challenge for the Ugu district would entail the development of decision making frameworks capable of leading to investment decisions that are beneficial under a wide range of possible climate outcomes. As a starting point the District will be required to effectively implement their Asset Management Policy and maintain up to date asset register to facilitate a thorough understanding of the actors, on-going activities and available models and datasets upon which any new work will build and developing a conceptual framework integrating climate change into development planning and asset management plans.

A key factor in the vulnerability of infrastructure is high level of interdependence of essential infrastructure. Electricity supply, for example, is essential to multiple systems, and a failure in the electrical grid can affect water treatment, transportation services, and public health.

2.5.3 Vulnerability in Water Resources

Water and Sewerage Services	
• Storm water and Sewage	• Inundation of storm water and sewage systems; • Increased peak flow rates; • Changes in groundwater levels; • Shifting flood plains; and • Reduced dry weather flow rates. •
• Wastewater	• Increased intensity of precipitation may cause intrusion into waste water networks; and • Potential for blockages and overflows. •
• Water supply	• Changes in the mean and peak flow rates of rivers and streams; • Reduced groundwater recharge; • Increased treatment due to poorer water quality (potential taste/odour/ dissolved iron and manganese problems); • Unreliable/insufficient water supply; • Increased risk of contamination; • Salination of water sources; and • Changes/shifting of groundwater used for irrigation.

With variations in rainfall patterns (both natural and through climate changes) and the local economies' dependency on water availability, water resource management will become a critical component of the UGU DM's climate change strategy.

Pressure in the water sector as a result of drought frequency and intensity changes will be noted most severely in the domestic sector resulting in water restrictions. This will be particularly prevalent among households receiving a larger proportion of reticulated water being Umdoni and Hibiscus Coast. Those areas relying on borehole water are however entirely dependent on sufficient water in the water table to meet their needs. They are unable to have access to water outside of their immediate vicinity as those with access to reticulated water are able to do, provided there is sufficient water to meet this domestic need.

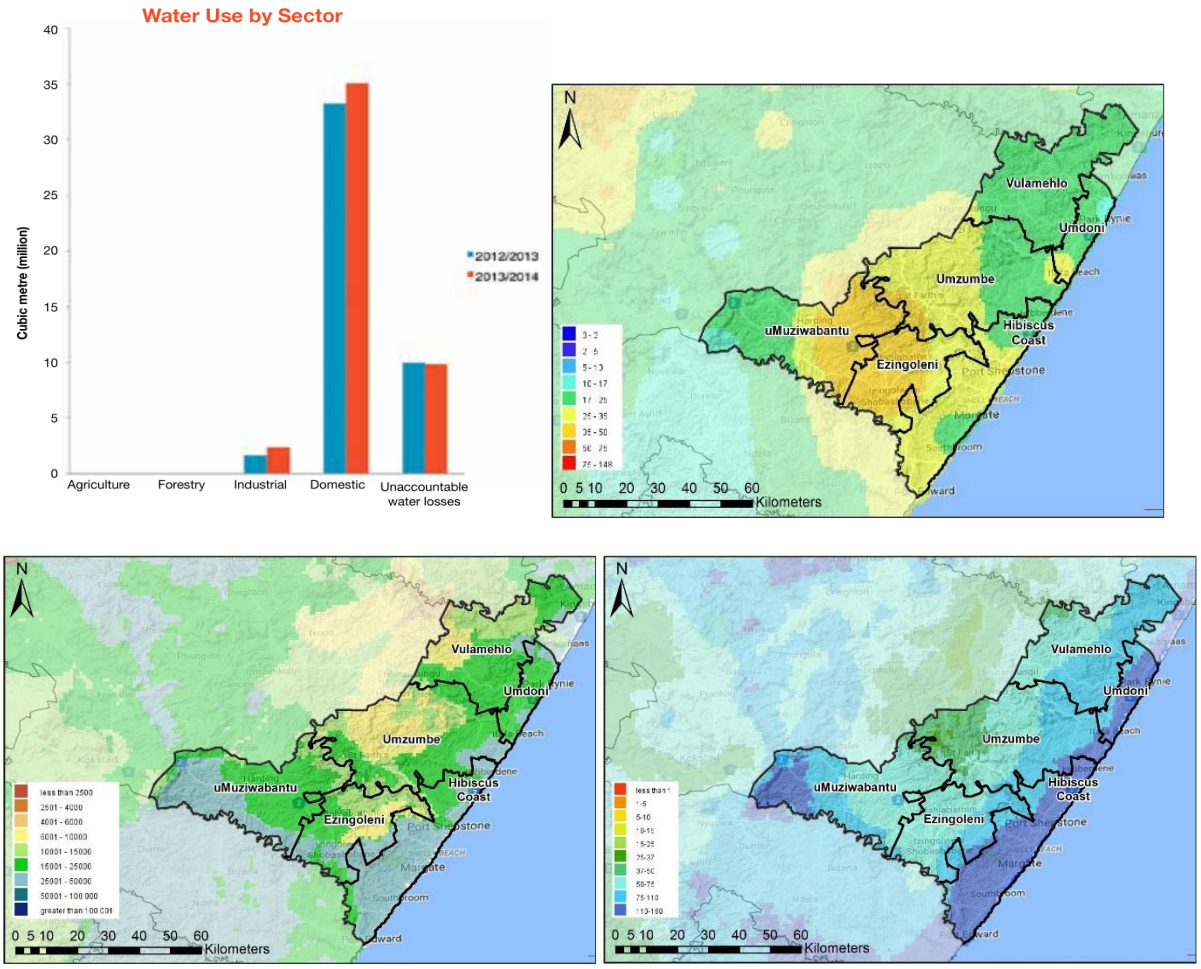


Figure 21: Sectoral water use – top left[43] , Depth to groundwater (m) – top right, Utilisable Exploitation Potential under dry conditions (mm) – bottom left and Groundwater Recharge (mm/year) – bottom right[44]

The impacts of drought events are sever due to highly limited excess capacity on existing water resources in light of through a growth and development and associated water requirements. Drought events are however normal in the atmospheric cycle and require resilience building in order to sustain communities and industrial usage. To address this exposure to drought Ugu DM has earmarked for water schemes that are supplied by groundwater and river resources. Resilience in the water sector in the face of variable rainfall patterns and impacts on rivers system could be augmented though the sustained utilisation of groundwater resources. Ugu DM does have the potential to utilise ground water to complement current supply. The majority of the district has ground water at depths at 25m or deeper, the shallower areas though already have a higher density of boreholes currently. Current high exploitation potential and annual recharge are noted in the coastal areas and to the western side of uMuziwabantu.

Currently there is significant major water infrastructure present in order to build resilience to drought impacts. This includes[45]:

- 7 Dams;
- An estimate 4 300 km of pipelines;

[43] Ugu District Municipality, Annual report 2013/2014

[44] South African Risk and Vulnerability Atlas, CSIR

[45] Ugu District Municipality. 2015. Ugu District Municipality: Water Services Development Plan-IDP Water Sector Input Report 2015/2020, Port Shepstone, KZN.

- 153 Reservoirs;
- 125 Pump stations;
- 18 Water treatment works;
- 20 Waste water treatment works (Ugu DM, 2015).

In addition there is the proposed Cwabeni off-channel storage dam which will increase the available water yield of the Umzimkhulu Regional Water Supply Scheme[46]. This scheme supplies domestic and industrial water to the Southern Coast of KwaZulu-Natal from Hiberdeen to Margate, including Port Shepstone. The system's main water users are located within the Ugu District Municipalities and include the Hibiscus Coast and Umzumbe Local Municipalities. This scheme was Government Gazetted for public comment in 2016 (No.139, 3rd February 2016, Department of Water and Sanitation). The reservoir can be filled both from its incremental catchment and supplemented by pumping from the Umzimkhulu River during times of high river flows. The total requirement to be supplied by the Cwabeni Dam within the Umzimkhulu Regional Water Supply Scheme for the planning date of 2040 is 30 million m^3/a (DWS, 2012). The increase in storage that the Cwbeni off-channel storage dam will provide is particularly important in the context of changes to the hydrological cycle due to climate change. If rainfall intensity and runoff increase then more surface water storage is required to mitigate these changes. Having the dam site situated off the main Umzimkhulu River stem reduces the sedimentation impacts. That said it is important to have adequate catchment practices in place both at the district municipality and farm level to reduce erosion and sedimentation.

Pressure placed on the water resources sector can be attributed to development (particularly along the coastal areas) and the resulting increased water demand. Adaptation to this growth needs long term strategic planning, yet addressing the not insignificant water is lost each year as well as implementing water demand management practices would help address water shortage exposure in the short term. Urgency should be given to prioritising maintenance and monitoring of water infrastructure in order to reduce this inefficiency and loss while long term planning is considered to offset future water sector sensitivity to climate changes.

2.5.4 Vulnerability in Terrestrial Biodiversity

Natural Resource Management	
• Biodiversity	• Changes in the distribution of invasive species and associated loss of biodiversity and subsequent altered veldfire intensity; • Changes in the geographical distribution of indigenous fauna and flora; • Increased risk of species extinction; • Reduced ecosystem resilience; and • Increased stress on ecosystems and ecosystem services.
• Coastal Management	• Increased erosion and inundation; • Loss of natural assets; • Loss of beach width; and • Changes to wetland and estuary ecosystems due to sea level rise, erosion and saline intrusion.

There is evidence of degraded natural assets and resources due to uneven environmental management. However, the District is committed to adopting a green approach to activities taking place in the District. Serious concerns have been raised with regards to potential over exploitation of resources, loss of

[46] Department of Water and Sanitation (2012) Cwabeni Off-Channel Storage Dam, Feasibility Study: Volume 1: Module 1: Technical Study. Report No: P WMA 11/T52/00/331/8, Pretoria RSA.

coastal forests, loss of bushlands and grasslands, loss of ecosystem services, air pollution, soil erosion, decreased soil fertility, overgrazing, decreased ecological linkages, as well as uncontrolled urban and rural sprawl.

The district has made significant inroads with regards to integrated environmental management through the development of Strategic Environmental Assessments, Environmental Management Framework, Integrated Waste Management Plan, Air Quality Management Plan, Air Quality Management by-laws and adoption of an Integrated Coastal Management programme. Despite significant process the Ugu DM acknowledges that some gaps remain. With specific reference to Invasive Alien Species Management Plan and a Health and Hygiene Education Strategy.

The Ugu DM's IDP (2015) provides a detailed trends analysis outlining the environmental challenges faced by the district. The challenges highlights vulnerabilities relevant to the climate change risk assessment and environmental sustainability will share various mutually reinforcing objectives with the districts strategic approach to climate change adaptation.

○ Biodiversity vulnerability

The Ugu DM spatial economic overview highlights the economic benefit of ecosystems and the services they offer in contributing to resilience mitigating the effects of meteorological and climate related hazards.

Ugu currently has approximately 50% of land classified as untransformed natural vegetation. The integrity of this natural land is however compromised through processors such as "over-grazing, injudicious burning practices, unchecked sheet and gully erosion, the spread of alien invasive plants, the inappropriate placement of infrastructure, and externalities emanating from settlement -, agricultural – and industrial land uses[47]". The prevalence of commercial agriculture of sugar cane and timber plantations in the inland areas, have further exacerbated this deterioration through the large scale of land transformation. Along the coastal areas transformation of ecosystem service providing areas (such as estuaries and flood plains) results in compromised ecological integrity though the unchecked commercial, industrial and residential development.

The loss of natural resilience and buffer zones to the hazard exposure Ugu DM to heightened risk of increased "…frequency and severity resulting in extremely high costs of disaster management, the loss of opportunity costs, as well as societal costs which often include the loss of life."[44]

The Ugu DM spatial economic overview (Figure 22) shows the areas that are currently providing ecosystem services in the form of environmental resilience. The coastal belt, most of which has been transformed, is exhibits little resilience and will be exposed to risks of sea level rise or storm surges. The inland commercial agriculture areas are also shown to have reduced ecosystem service provision. The large scale transformation to (mostly) mono culture of the natural land have compromised the sustained functioning of ecosystems.

[47] Ugu District Municipality, A spatial economic overview, March 2012

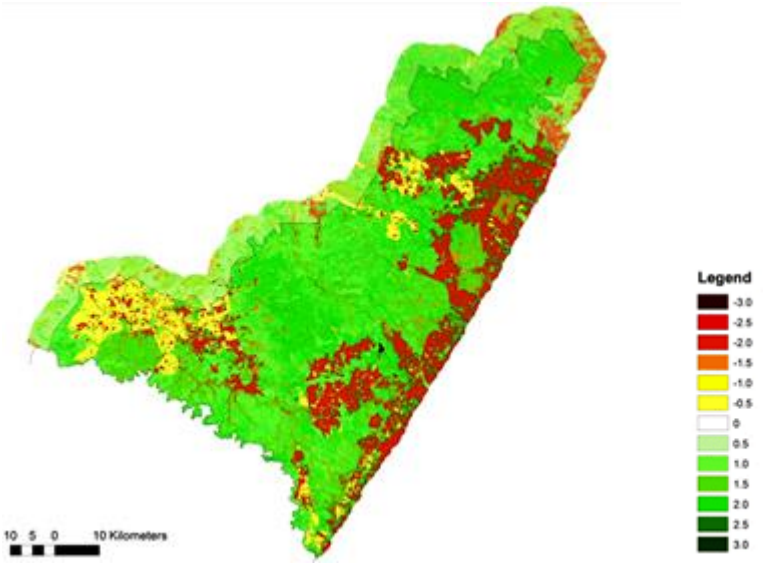


Figure 22: Ecosystem service potential[48]

Ezemvelo KZN Wildlife conducted an assessment for the quantified value of the ecosystem services derived from varying area types scaled down to Ugu DM (Figure 23). These services include, among others, supportive services that are integrated into the functioning of all ecosystems such as nutrient recycling and soil formation; regulating services such as carbon recycling, water and atmospheric filtering and waste decomposition They also include provisioning services and are comprised of products derived from ecosystems such as timber, fuel, food, water, minerals and medicinal benefits but also non material cultural services such as ecotourism, recreational, educational and spiritual benefits.

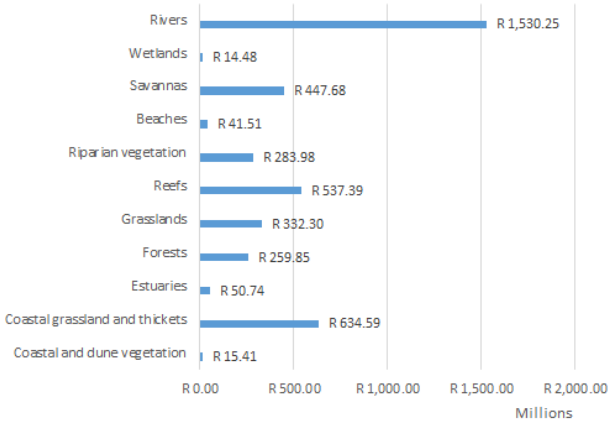


Figure 23: Quantified ecosystem service value

Ecosystem services derived from rivers and riparian vegetation are estimated to account for R1.8 billion annually and provide services directly benefiting communities like water purification, aqua-culture, water table rejuvenation and habitat support. The integrity of natural systems of coastal grasslands and dune vegetation, reefs, beaches and estuaries will directly mitigate the impacts of sea level rise, tidal swash and storm surges. In the context of climate changes, where current meteorological and ocean based hazards are likely to increase in frequency and severity, the importance of maintaining or rehabilitating these areas such that the ecosystem services enhanced are paramount. Investment into the “restoration

[48] Modified from Ugu District Municipality, A spatial economic overview, March 2012

and sustainable management of natural capital, at a fraction of the latter costs, will result in reduced vulnerability and enhanced resilience to extreme weather events."[49]

The biodiversity vulnerability is highlighted in the current state on the environment in the district. The biodiversity of Ugu DM is highly varied between the different local municipalities and consists of formal protected and marine protected areas, critical biodiversity, ecological support, estuary priority areas, landscape corridors and wetland/freshwater priority areas. The integrity of these natural environments will influence species resilience to both long term climatic and short term meteorological impacts.

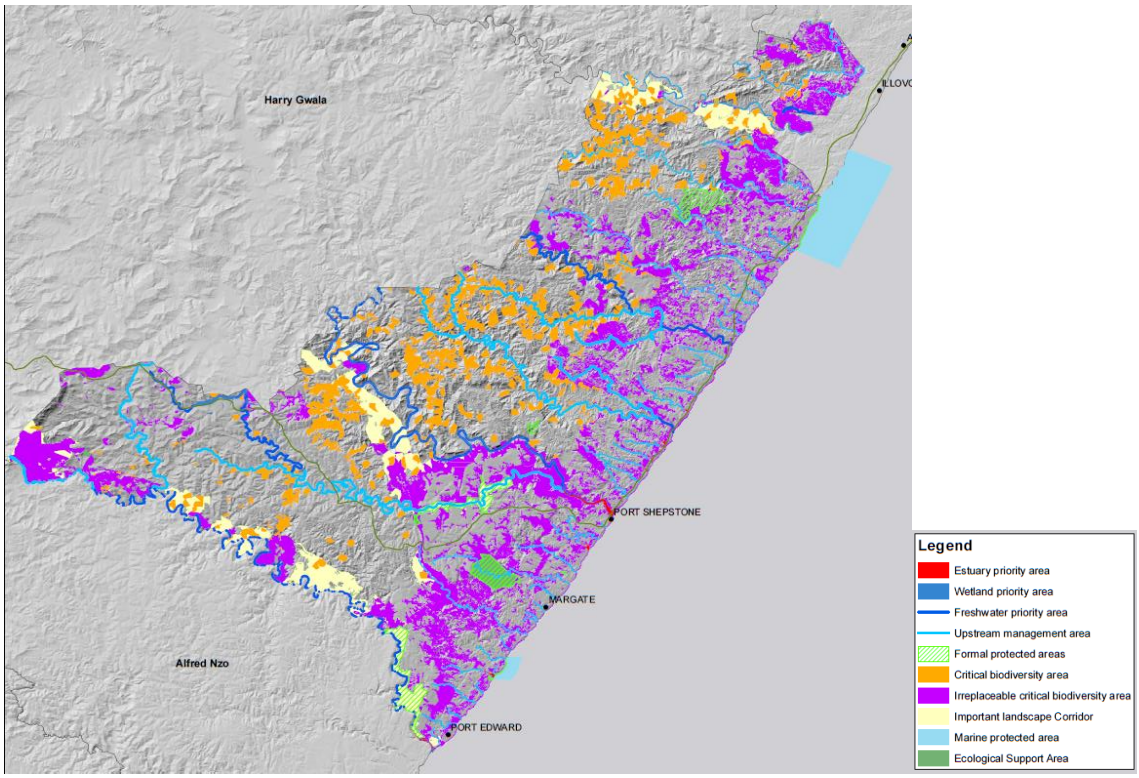
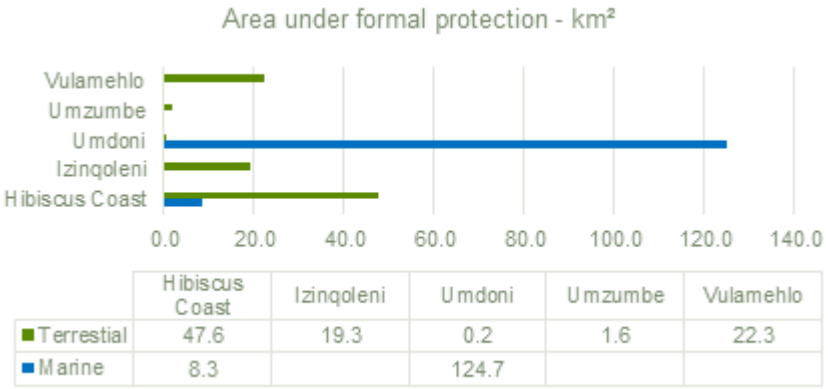


Figure 24: Spatial biodiversity assessment

Formal terrestrial and marine protected areas

Protected areas as declaration under NEMPA to maintain an area in a natural state with limited to no biodiversity loss. Both Umdoni (Aliwal Shoal) and Hibiscus Coast (Trafalgar) have marine protected areas with no catch areas to protect fish species and breading habitats. Terrestrially, Hibiscus Coast (Umtamvuna, Mbumbazi, Mpenjati nature reserves among others) has the majority of the protect areas with Vulamehlo (Vernon Crookes) and Izinqoleni (Oribi Gorge) following. Areas consisting of formal protection will better be able to maintain ecosystem services including ecotourism for revenue generation

[49] Ugu District Municipality, A spatial economic overview, March 2012



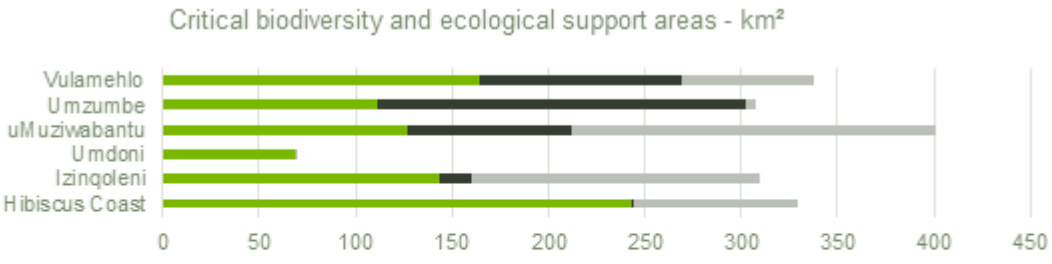
	Hibiscus Coast	Izinqoleni	Umdoni	Umzumbe	Vulamehlo
Terrestial	47.6	19.3	0.2	1.6	22.3
Marine	8.3		124.7		

Figure 25: formal protected areas

Critical Biodiversity and Terrestrial Ecological Support Areas

Areas that are required to be maintained in a natural state such that landscapes (terrestrial and aquatic areas) are able to ensure the persistence of viable populations of species, and the functionality of ecosystems and ecological infrastructure (Functioning ecosystems that deliver services to people and the environment) through limitation of the impact to thresholds and limited to no biodiversity loss. Ecological Support areas also contribute to the functional maintenance of ecological infrastructure though the full area is not necessarily required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the Critical Biodiversity Areas and some loss of biodiversity will not significantly impact ecosystem functionality and connectivity. Protection of these areas is required in order to maintain connectivity between natural areas and are critical for the long term persistence of both ecosystems and species, in the face of human development and global climatic change. High levels of infrastructural and agricultural development within these areas restrict the connectivity of ecosystems and therefore restricts the movement and long term sustainability of plant/animal species.

Hibiscus Coast has the highest area marked as irreplaceable biodiversity, while Umdoni has the highest ratio of irreplaceable to optimal and support areas. This is due to the encroachment of development limiting the space available to natural systems and the remaining natural areas are essential for maintaining ecosystem functionality. The remaining local municipalities exhibit a high proportion of optimal and support area to irreplaceable areas.

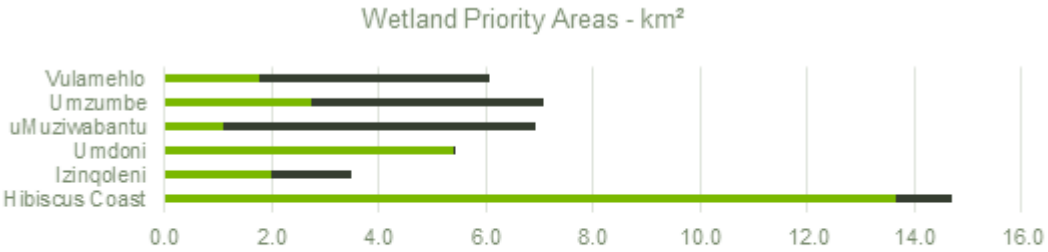


	Hibiscus Coast	Izinqoleni	Umdoni	uMuziwabantu	Umzumbe	Vulamehlo
CBA: Irreplaceable	242.7	143.8	68.5	127.1	111.5	164.5
CBA:Optimal	1.9	16.6	0.0	85.0	190.5	104.2
Ecological Support Area	84.4	149.0	1.0	189.0	5.1	69.3

Figure 26: CBA and ESA Areas

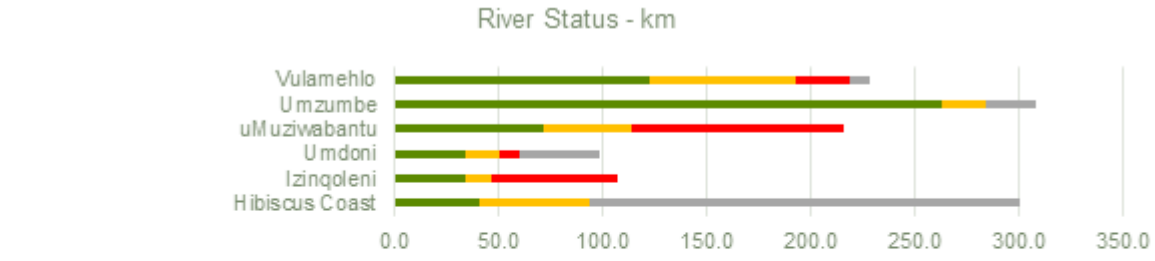
Wetland and Freshwater Priority Areas

Maintaining these areas in a natural or near natural state will assist in services such as increased flood attenuation and sustained habitat for a various aquatic biota. Freshwater resources are strategic conservation priorities for ecosystems and species, and for enhancing water security. Hibiscus Coast has the largest area under wetland status, the majority of these however are lower priority wetlands. Vulamehlo, Umzumbe, uMuziwabantu and to a lesser extend Izinqoleni have a significantly higher proportion of high priority wetlands. These areas also have the larger length of "largely natural" rivers (with the exception of Izinqoleni). The rivers that have been largely modified are less able to provide habitats for flora and fauna and have limited ecosystem stability. Conservation of priority natural and only moderately modified areas is essential to the health of water resources in the district through the ecological services rendered in wetlands.



	Hibiscus Coast	Izinqoleni	Umdoni	uMuziwabantu	Umzumbe	Vulamehlo
Lower Priority	13.7	2.0	5.4	1.1	2.7	1.8
High Priority	1.0	1.5	0.0	5.8	4.3	4.3

Figure 27: Wetland Priority Areas



	Hibiscus Coast	Izinqoleni	Umdoni	uMuziwabantu	Umzumbe	Vulamehlo
CLASS B: LARGELY NATURAL	41.2	34.2	33.8	71.3	262.9	122.0
CLASS C: MODERATELY MODIFIED	52.7	12.1	16.4	43.0	21.0	70.6
CLASS D: LARGELY MODIFIED		60.7	10.0	101.7		25.8
unknown	206.0		38.5		23.7	10.2

Figure 28: River Status

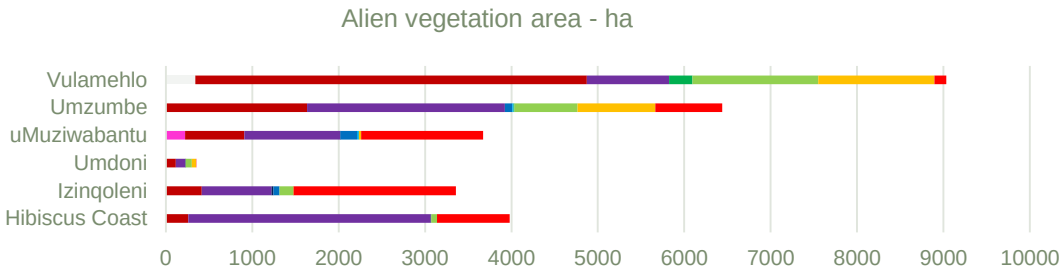
Invasive alien vegetation

Invasive alien vegetation transforms the natural ecosystem and compromises the ability to deliver goods and services. Some of these detrimental effects on services are "the quantity and quality of water delivered, flood control, erosion control, and food production"[50]. The National Invasive Alien Plant Survey project was initiated by the Working for Water Programme and implemented by the Agricultural Research Council. Though the presents of alien invasive plants may be beneficial from the perspective of vegetation acting as a buffer to meteorological hazards in the short term, the transformation that occurs over a longer time frame may ultimately impact the capacity of an ecosystem to remain

[50] Valerie T. Eviner, Kelly Garbach, Jill H. Baty, and Sarah A. Hoskinson; Measuring the Effects of Invasive Plants on Ecosystem Services: Challenges and Prospects; 2012; Invasive Plant Science and Management 2012 5:125–136

sustainable. Alien invasive species therefore will compromise the biodiversity of an area an increase exposure to climatic hazards. However it should be noted that where changing environmental conditions are no longer suitable to indigenous vegetation species, alien species may contribute to the functioning of ecosystems. Therefore an in-depth environmental assessment should be undertaken when considering alien clearing projects.

The main invasive species in Ugu DM are Eucalyptus – 8077ha, Chromolaena odorata (Triffid) – 7646ha (Siam weed), Wattle species – 5040ha, Senna didymobotrya – 2484ha (African senna) and Solanum mauritianum -2320ha (earleaf nightshade). The impacts of these species range from excessive water use and killing natural completive species through chemical release (Eucalyptus), biodiversity impacts and fire regime alteration (Chromolaena odorata), out competing grasslands though fast growth (Wattle) and causing health problems in humans through toxicity and causing respiratory problems (Solanum mauritianum).



	Hibiscus Coast	Izinqoleni	Umdoni	uMuziwabantu	Umzumbe	Vulamehlo
Caesalpinia decapetala		1		225		1
Cereus jamacaru						339
Chromolaena odorata	262	416	115	684	1636	4533
Eucalyptus species	2803	806	114	1113	2290	952
Lantana camara	7	23		0		
Melia azedarach		72		191	82	
Opuntia species				22	16	
Pinus species			1		11	269
Senna didymobotrya	66	160	71	2	728	1458
Solanum mauritianum	1	1	47	27	902	1342
Wattle species	842	1877	0	1410	772	139

Hibiscus Coast is most infested with Eucalyptus species and wattle, as is the case with Izinqoleni and uMuziwabantu. Umdoni and Umzumbe have predominantly Chromolaena odorata and Eucalyptus. Vulamehlo has a dominance of Chromolaena odorata and large areas of Senna didymobotrya and Solanum mauritianum. Vulamehlo and Umzumbe have the largest area of invasive species with 9033 and 6520ha respectively. Izinqoleni with 3356ha however has a large proportion of the relatively small municipality covered by alien invasive species.

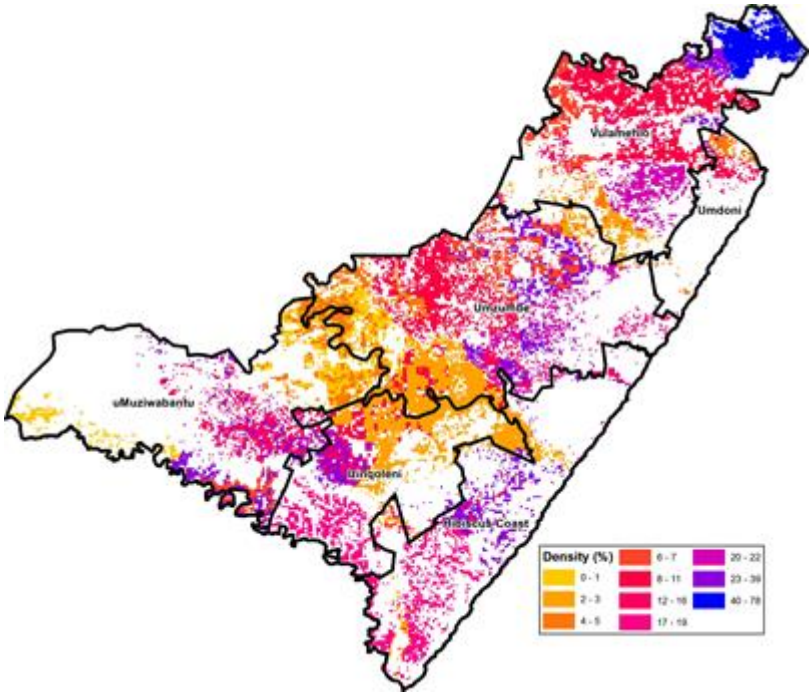


Figure 29: Alien vegetation density distribution

○ Coastal vulnerability

The National White Paper on Sustainable Coastal Development in South Africa acknowledges that South Africa's coast is vulnerable to degradation and overuse. Coastal features of particular importance in Ugu include coastal public property and the coastal protection zone. Coastal public property is entrusted by the state on behalf of the citizens in order to ensure that it is protected. The coastal protection zone regulates the use of land that forms part of the coastal ecosystem. Therefore particular activities listed in the National Environmental Management Act that take place in this zone require authorisation from the Department of Agriculture and Environmental Affairs.

In keeping with the requirements of the National Environmental Management: Integrated Coastal Management Act No 24 of 2008, Ugu has developed an Integrated Coastal Management Plan as part of the Working for the Coast Project. The plan provides a strategic framework for the management of the coastal zone and includes a vision for coastal zone management and the sustainable use of coastal resources. Direction for forecasted expenditure and investment by the Ugu District Municipality in coastal management infrastructure is given by the Coastal Management Plan.

The Kwazulu-Natal Coastal Vulnerability Index (CVI) assessment was undertaken with the aim of addressing the erosion impacts posed through the predicted increase in frequency and intensity of storms resulting in higher storm surges. The CVI improved the understanding of coastal vulnerability to extreme weather, coastal erosion impacts and sea level rise. The physical vulnerability of the coast was determined by assessing beach width, dune width, distance to the 20m isobath, and the percentage of rocky outcrop and the width of the vegetation behind the back beach. The sea level assessment undertaken here builds on the methodology presented by the CVI with particular focus on horizontal inundation potential through the physical structure of the coastline and the inherent ability to dissipate incoming wave energy. It applies the Bruun model[51] logic to provide a first level estimate of coastal risk

[51] Bruun, P. 1988. The Bruun rule of erosion by sea level rise: a discussion on large-scale two and three-dimensional usages. Journal of Coastal Research 4 (4): 627 – 648.

as a result of changes to breaker zone depth. Furthermore it assesses the locations of estuaries (and priority estuaries) and in proximity of ecological corridors relative to the physical coast. The combined coastal risk incorporates these physical and ecological parameters highlighting the exposure potential relative to each 1km stretch of Ugu coastline.

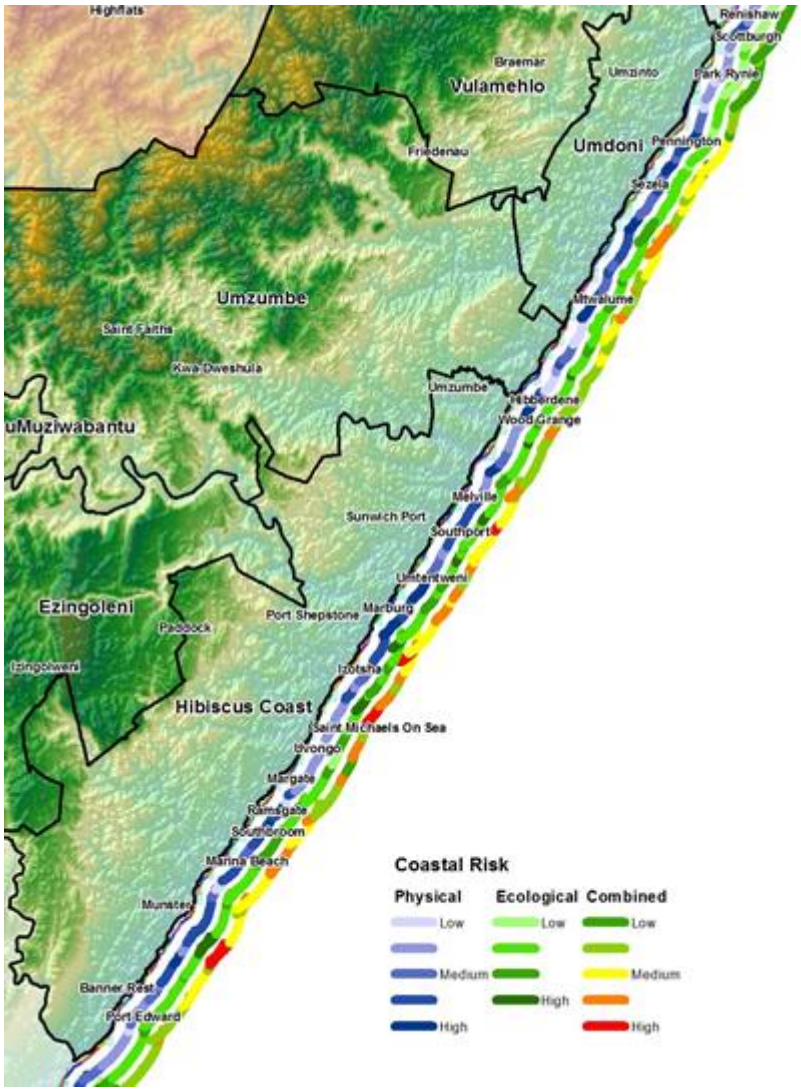


Figure 30: Coastal risk based on physical and ecological vulnerability (risks offset)

The coastal risk combines proxy analysis for the physical and ecological status of following parameters:

- The distance from the coastline to the 20m isobath which informs the potential dissipation of wave energy. This dissipation will reduce coastal erosion and wave swash in both normal circumstances as well as during heightened storm surge events. Furthermore the gradient of the breaker zone or nearshore zone will change the deposition depth of eroded sediment thereby altering the base nearshore depth. The east coast of South Africa has a narrow continental shelf (compared to the west coast) and as such the 20m isobath is often close to the beach zone.
- The width (proxies from contour data) of the beach zone is the range of the wave swash and intertidal zone under normal circumstances. The shallower the gradient and larger the width of the beach zone the greater the surface friction present to dissipate wave energy and erosion potential.

- The width of the back beach area (proxies from contour data) will influence force of incoming swash and dissipative potential. The further width of the back beach will increase surface friction and more physical resilience to the impacts (erosion and inundation) associated with more extreme storm surges and wave run-up. The greater the width of the back beach, the further the coastal setback for public and private assets and infrastructure. The greater the width the more area for adaptive intervention potential to limit sea-level rise implications such as erosion control and energy absorption.
- The rocky outcrop to soft sandy beach ratio will inhibit the loss of beach sediment through erosion and also act to mitigate and disperse incoming wave energy and swash.
- The ecological sensitivities is informed by the estuaries (priority and non-priority) and ecological corridors as indicated by SANBI analysis weigh the impacts of the physical coastal risk against the estuary systems. Impacts to the estuary and ecological corridor areas will have significant ramifications (both direct and non-direct) for ecological health, maintenance, goods and services of productivity, function and habitat.

The KwaZulu Natal coast CVI shows that 30% is at low risk, most of the coast (47%) is at moderate risk and 23% is at high risk. When assessing the Ugu specific sea level rise impact potential, the vulnerability measure agree with the KZN assessment. The risks further resolution with the break down with combined risks coming to Minimal 11%, Low 23%, Moderate 33%, High 24%, and Significant 9%.

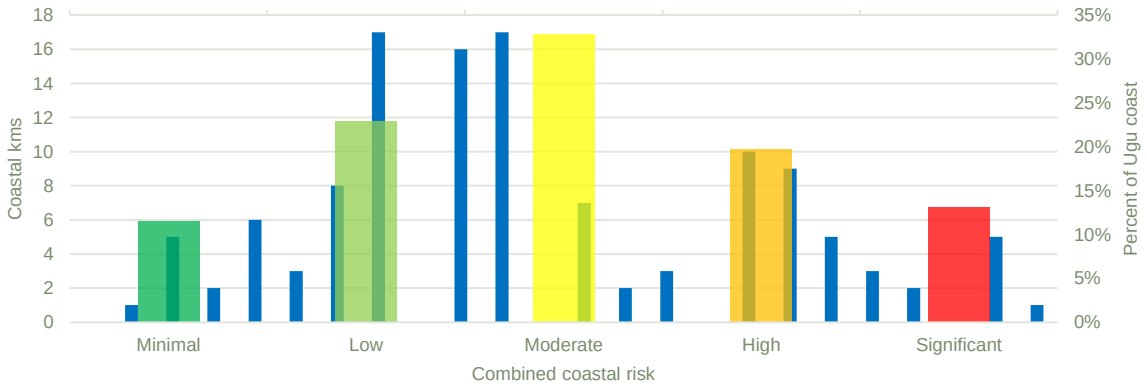


Figure 31: Coastal Risk Profile (blue bars – quantitative risk, coloured bard – categorised risk)

Ugu's coast is vulnerable to coastal erosion which is exacerbated by extreme weather events and sea level rise. Dunes, sandy beaches, flood plains and coastal vegetation protect the coast against erosion. Therefore, if these natural areas are not managed sustainably the coast could lose its ability to withstand the impacts of climate change. Umzumbe, Pennington, Rocky Bay and Scottburgh are the most vulnerable to spring high tides[52]. Ugu's coast has thick vegetation along its dunes therefore there is no need for immediate rehabilitation of coastal erosion. However, it is important to note that there are areas where coastal erosion exists but Ugu has strategic plans in place to keep the extent of coastal erosion manageable.

Estuary Priority Area

Estuary areas that receive limited to no loss and impact as they perform essential functions such as providing nursery areas for marine fish, conduits for species which move between ocean and rivers and feeding and staging sites for significant populations of migratory birds. High priority estuary areas and noted particularly in Hibiscus Coast. The loss or degradation of the areas will impact species nursing ability and reduce the potential ecosystem services from the area.

[52] Ugu District Municipality Coastal Management Programme (DRAFT), 2015

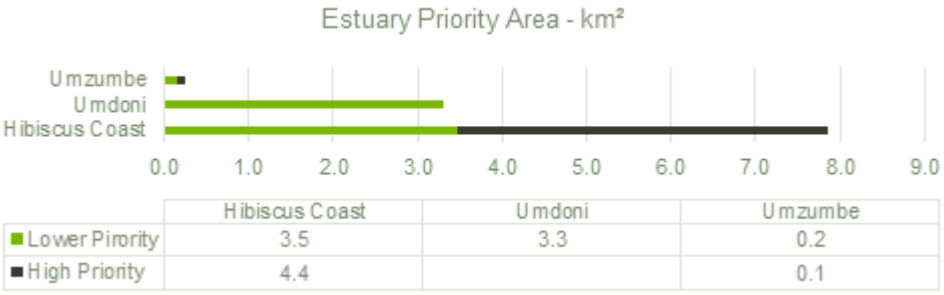


Figure 32: Estuary Priority areas

2.5.5 Vulnerability in Disaster Management

Public Safety	
• Health and Disaster Management	• Changes in geographical range and seasonality of vector-borne diseases specifically Malaria and Dengue; • Increased incidence of food and water-borne diseases due to increased temperatures; • Health impacts related to extreme precipitation and temperature events; • Intrusion of contaminants and pollutants into water sources due to excessive/intensified rainfall; • Increased demands on emergency response and recovery resources; • Public dissatisfaction with the government's response could lead to conflict; and • Adverse impacts on public safety and tourism, could impact regional economic performance.

Projected climate change will pose additional challenges for disaster risk management objectives, the appropriate allocation of resources for disaster risk reduction. This is related to the high likelihood of climate change increasing the occurrence and variability in the location of some meteorological events, which in turn will affect the exposure faced by many communities, as well as their vulnerability. The increased exposure and vulnerability attributed to climate change would contribute to an increase in disaster risk. For example, vulnerability may increase due to direct climate related impacts on the development and development potential of the affected area, because resources otherwise available and directed towards development goals are deflected to respond to those impacts, or because long-standing institutions for allocating resources such as water no longer function as intended if climate change affects the scarcity and distribution of that resource[53].

Another significant factor in the relationship between climate change and disaster risk is the fact that climate change will make it more difficult to anticipate, evaluate, and communicate both probabilities and consequences that contribute to disaster risk, in particular that associated with extreme events.

Many of priority risks as identified in the Ugu DM disaster management sector plan (Table 4) will be subject to changes in frequency of occurrence and impacts either directly as a result of changing acute meteorological events or indirectly thought chronic longer-term changes in community or area vulnerability. Future disaster management plans will require knowledge and application of climate related impacts before making long term response recommendations.

[53] Lavell et al., 2012

The implications of risk identified in Ugu's disaster management plan to climate changes are presented in Chapter 4.

Table 4: Priority Risk from Ugu DM disaster management sector plan

Umdoni	Vulamehlo	Izinqoleni	Hibiscus Coast	Umuziwabantu	Umzumbe
Air pollution	Cholera	Cholera	Cholera	Cholera	Cholera
Drought	Drought	Dam failure	Drought	Drought	Deforestation
Fire	Fire	Drought	Fires	Fires	Drought
Floods	Floods	Fire	Floods	Floods	Fires
HIV	HIV	Floods	Hail Storms	Hazmat by road	Floods
Land Degradation	Land degradation (trees)	HIV	Hazmat by road	HIV	Hazmat by road
Oil pollution	Severe storms	Hazmat by road	Hazmat by rail	Land degradation	Rabies
Rabies	Shigella Dysentery	Land degradation	Industrial waste/storm water	TB	Severe weather
Severe storms	Storm surges	Severe storms	Land Degradation	Severe storms(wind)	TB
Shigella Dysentery	TB	TB	Measles	Water pollution	Waste and disposal
Tidal Wave	Tidal wave	Water pollution	Polio		Water pollution
Water pollution	Water pollution		Power outages		
			Rabies		
			Shigella Dysentery		

2.5.6 Vulnerability in Agriculture

Natural Resource Management	
• Agriculture	• Projected climate change may lead to inferior crop yields and poor veld conditions; • Reduction in and degradation of animal habitats; • Lack of livestock feed and drinking water; • Increase in disease outbreak and increased vulnerability to predation; • Increased risk of soil erosion; • Annual and perennial crop losses; • Damage to crop quality; and • Disruption of animal breeding and/or crop cycles. • Reduce employment opportunities in commercial sector; and • Increased livelihood and food insecurity among subsistence farmers.

KZN as a whole is considered highly exposed (risk that an event may occur) to droughts/floods and predicted climate change (Gbetibouo 2009[54]). KZN also has significant sensitivity or a degree of

[54] Gbetibouo, G.A., Ringler, C., 2009, Mapping South African Farming Sector Vulnerability to Climate Change and Variability, IFPRI Discussion Paper 00885.

influence from impacts of climate change and low levels of adaptive capacity. They further suggest that "coastal ecosystems are the most highly threatened systems in the world" (Gbetibouo 2009).

Agricultural type varies significantly between the municipalities. The majority of all agricultural land in Ugu engages in commercial farming (78%). This commercial area is focused primarily in Umdoni (40% total farming area) and in by followed by uMuziwabantu for the highest proportion of subsistence agriculture (13% total farming area). Commercial farming dominates the remaining municipalities with between 7% to 9% total land for commercial activities to 1% to 3% for total land for subsistence agriculture area.

The spatial distribution of commercial and substance farming is given in Figure 36 below

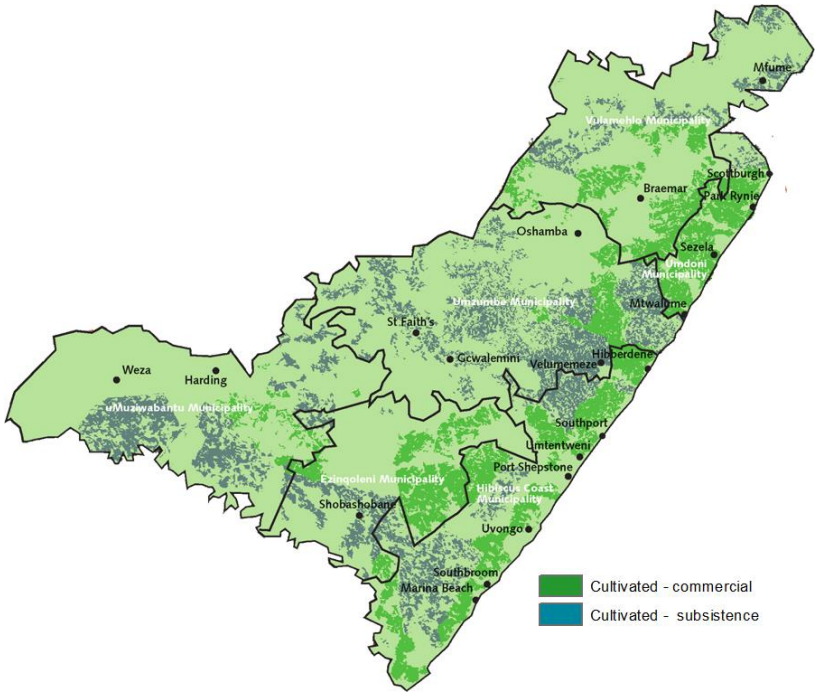


Figure 33: Commercial and substance farming[55]

The area covered by large scale commercial agriculture dwarfs subsistence farming. The total area available for agriculture is limited due to rugged hills and steel slopes particularly in Umzimkulu. This is particularly the case for commercial farming (which also generally avoids the tribal areas) which requires larger areas. Competition for space limits subsistence farming to use these less suitable hilly areas. Commercial agriculture consists predominantly of sugar cane in the coastal areas with timber plantations being found further inland. There is a general continuity in the ratio of commercial to rural farming between 75% and 85% toward the commercial side. This ratio is skewed to the commercial side in Umdoni and to the subsistence side in uMuziwabantu.

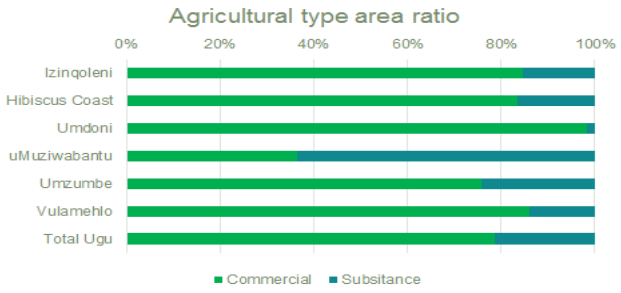


Figure 34: Total agriculture area per municipality and farming type (%)

[55] DAFF, Food Insecurity in Ugu

As is characteristic of South Africa, the UGU DM's agricultural economy consists of large commercial operation as well as smaller, mainly subsistence farming. Though there has been a decrease in the economic contribution of agriculture over the last few years there is still development potential in the agricultural sector. The gross value added by the agriculture, forestry and fishing sector to local economic development increased from 996 in 2009 to 1011 in 2011.However, employment in the sector has decreased from 11 143 in 2009 to 9 855 in 2011.[56] The main commercial and employment centre is Port Shepstone. Ugu produces 1/5 of all bananas eaten in South Africa. There also significant sugar-cane and timber farming produces pine, gum and wattle[57]. The commercial sector is however under pressure due to declining investment through declining commodity prices and import pressure. Furthermore there are increasing production costs and landuse competition from other commercial industries limiting sector development. The sector may also be hampered through water use pressures in the short term but by changes to the overarching climate altering the crop suitability in the long term. There is however some inherent resilience in the favourable labour market, the location and access to transport and sectoral support services. The prioritisation of the agricultural sector through appropriate strategic intervention on water use and utilization by both commercial and subsistence farmers of seasonal forecasting may assist in strengthening sustainability of the sector.

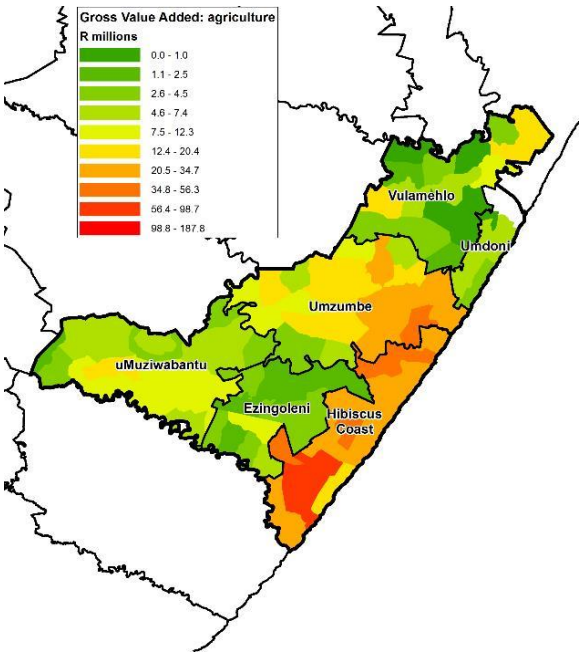


Figure 35: Agricultural sector value

As an important source of livelihood support for a large portion of the population, agriculture as a sector will require prioritization in terms of climate change adaptation. Apart from employment in the commercial sector, large numbers of household practice agriculture in order to supplement household income and meet nutritional requirements. Failing to address the risk posed to the agricultural sector will inhibit the impact of interventions to stimulate economic growth in the municipality's rural areas, further compounding food insecurity and poverty levels already characterising some of the local municipalities.

Commercial agriculture

Commercial agriculture plays an important role in the UGU DM's economy, contributing both in terms of GDP and employment. Research indicate that larger and more efficient commercial farms are less vulnerable to the impacts of climate change than smaller farms[58].The majority of the commercial farms

[56] Ugu District Municipality Annual Report 2013/2014: http://ugu.gov.za/Documents/Annual%20Reports/2013-2014/Annual-Report-2013-14.pdf

[57] Department of Cooperative Governance and Traditional Affair, Ugu District Municipality Profile 2011.

[58] Turple and Visser. 2013. Chapter 4: The Impact of Climate Change on South Africa's Rural Areas. 2013/14 Submission for the division of revenue, FFC.

in the district are well developed and although net profit margins may decrease as a result of the impacts of climate changes, farm management and access to technology will translate into improved adaptive capacity and serve to shield against climate change impacts if effective employed as adaptive strategies.

Subsistence agriculture

The exposure to climate related hazards will generally be higher among rural households and areas with less capital assets (human, physical, financial, social and natural) who support their livelihoods via subsistence agriculture. Diminished fluid capital reduces the adaptability of communities and farmers to compensate for damage or loss of crop or assets. Subsistence agriculture also traditionally relies on manpower which is vulnerable to short term meteorological hazards, as weather may turn be include more extreme events, there is greater susceptibility of the labour force. Subsistence farmers may also have to operate in conjunction with others on communal land potentially being exposed to a "tragedy of the commons" scenario where farmers seek the greatest benefit from a resource even though it may be directly detrimental to others (over grazing on communal land as an example). Farming practices in subsistence areas do not adapt with up-to-date technologies to enhance efficiency and do not account for seasonal variabilities or to long term climate predictors.

Table 5 and Table 6 presents the literature and local perspectives on agricultural exposure and capacities to resist climate impacts. Both highlight the increased risk in the subsistence farming areas over commercial farms as a result of decreased personal capacity and limited access to resources to buffer against hazard impacts.

Table 5: Agricultural exposure to variable climate and meteorological hazards

Subsistence / smallholder farms	Commercial agriculture
Impoverished sector, dominated by low-input, labour intensive production	large-scale, commercially oriented, capital-intensive, export-led
Land holdings in the former homelands are generally very small	wide variety of crops
Low irrigation ratio	High reliance on irrigation
Livestock currently exceeds the grazing carrying capacity in many areas	Limited land degradation
Limited access to resources, land, credit and technical know-how	Better infrastructure increasing crop quality, resource availability, accessibility and credit.
Climate change will increase the burden of those who are already poor and vulnerable	Climate changes may impact yield and reduce profitability as climate varies.
More sensitive to climate change and seasonal variability because they have less capital-intensive technologies and management practices. Have less access to forecasts and early warning systems. These farmers will have reduced ability to recover from impacts.	Less exposed to climate impacts and variability through access to credit, technology and knowledge. May have transport and water infrastructure to cope with adverse weather. Have better access to forecasts and early warning. Though not immune to impacts, these farmers should have better resilience to cope with and recover from hazards.

Table 6: Exposure and capacity in farm area types – local perspective

Subsistence / smallholder farms	Commercial agriculture
Exposure	
• Lack of education and awareness; • Access to and uptake water harvesting and storage methods;	• Food security related to high prices for basic goods;

• Poor irrigation practices; • Lack of resources for adaptation; • Low income; • Lack of support structures; • No access to insurance • Environmental degradation; • Lack of compliance and enforcement of legislation; • Existing fluctuations in prices of raw materials, e.g. seeds; • Responses are mostly reactive.	• Poor uptake of sustainable agricultural practices; • Reliance of natural water sources; • Lack of adequate insurance; • Environmental degradation; • Poor environmental management practices; • Disaster risk; • Lack of compliance and enforcement of legislation
Capacity	
• Social support within community; • Some farmer support projects, but limited	• Use of fire breaks; • Access to government assistance; • Access to knowledge and resources for climate change adaptation; • Significant level of awareness among commercial farmers; • Established public and private support structures for commercial farmers.

2.5.7 Vulnerability in Tourism industry

Marine activities (like the Sardine run, scuba diving, whale watching and fishing) are major tourist attractions in Ugu thus most tourist facilities are located along the coast. Ugu's tourism sector has the potential to create numerous job opportunities which can reduce poverty in the district and increase economic growth.

Ugu attracts approximately 10% of domestic tourists in KwaZulu Natal. Tourism is included in 'wholesale and retail trade, catering and accommodation' which makes up 17% of the Ugu Municipality District economy (2011)[59]. The graph below displays the percentages that each local municipality contributes to the tourism industry in the Ugu district[60].

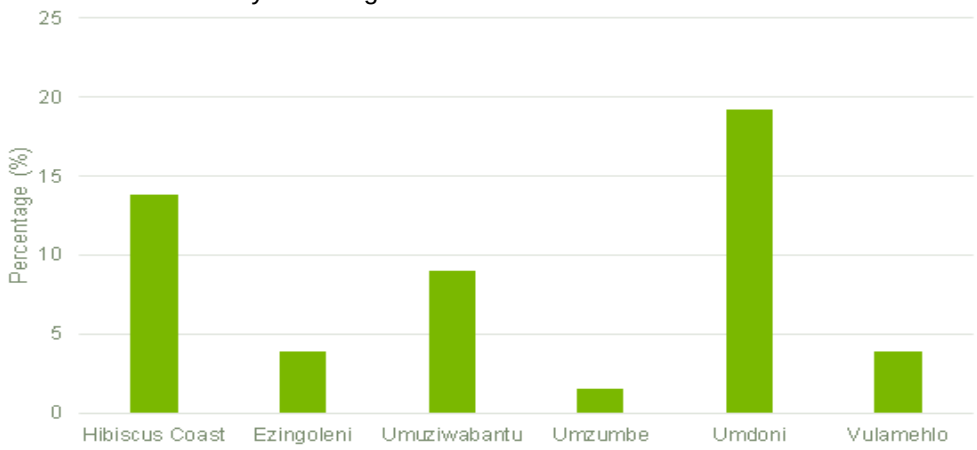


Figure 36: Tourism contribution per LM

Tourism Seasonality:
The Ugu Municipality District experiences a generally warm, sunny climate all year which means that the weather is almost always suitable for the above-mentioned tourist activities. In the past, the main

[59] Invest in KwaZulu-Natal, South Coast (Brochure), http://www.scda.org.za/scda-brochure/
[60] Ezinqoleni Municipality IDP 2015/2016, http://ezinqoleni.gov.za/publications/municipal-idp

tourism seasons were during the April, July and December school holidays. However, the December school holidays have become the main tourism season[61]. The school holidays are generally as follow:

Mid-March – Early April	Late June – Mid July
Late September – Early/Mid October	Early December – Mid January

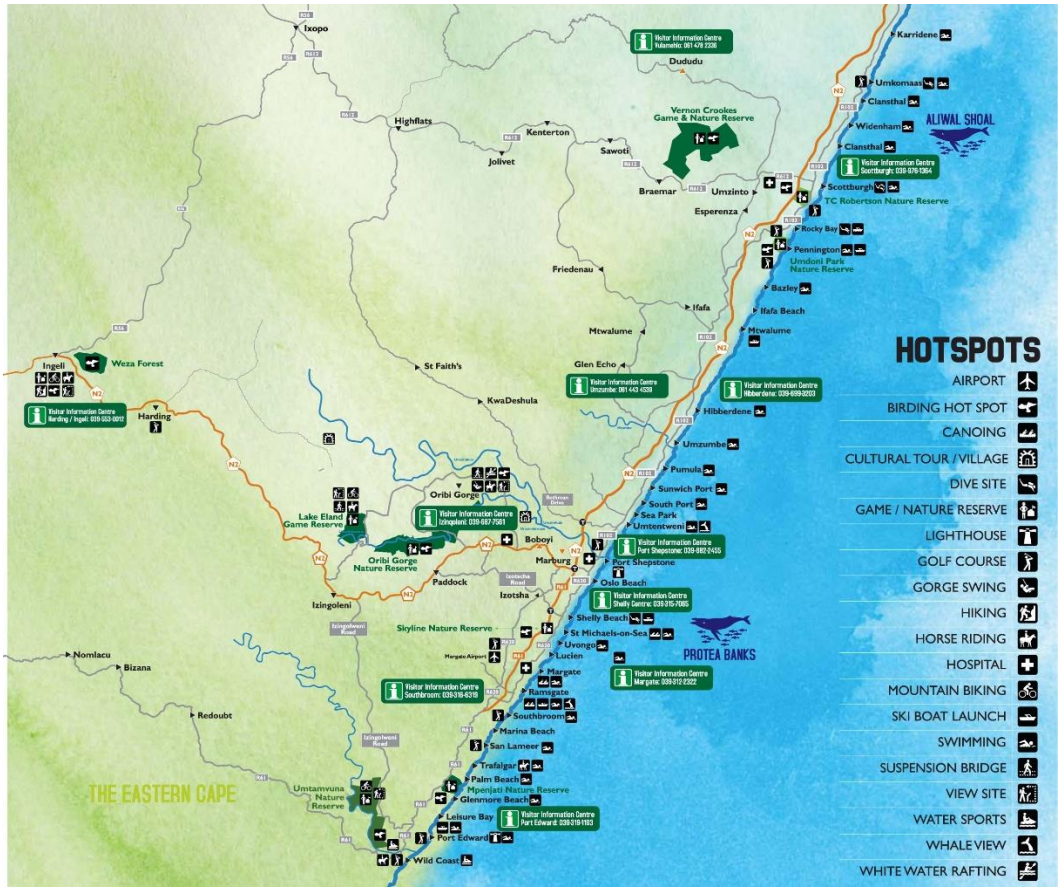


Figure 37: Ugu Tourism hotspots[62]

○ Tourism by Local Municipality

Umzumbe Local Municipality[63]

Umzumbe Local Municipality has a rich culture and has the potential to attract cultural tourism64. The area also has many natural resources such as the coast which can be used to promote coastal and eco-tourism. Another opportunity lies in Agritourism. Umzumbe Local Municipality plans to enjoy tourism benefits such as job creation by 2030. In order to achieve this goal the municipality has identified numerous tourism development initiatives.

---

[61] Ugu South Coast Development Agency, http://www.scda.org.za/tourism/

[62] Modified from Map of the South Coast, South Coast tourism, www.tourismsouthcoast.co.za

[63] Umzumbe Local Municipality IDP 2014/2015, http://www.umzumbe.gov.za/DRAFT%20IDP%202014%20-%202015%20-%2028%20March.pdf

[64] Mnguni, E., 2014. The role of traditional leaders in the promotion of cultural tourism in the south coast of KwaZulu-Natal: a case study of Umzumbe municipality. Journal of Educational and Social Research, 4(6), http://www.mcser.org/journal/index.php/jesr/article/view/4088

Izinqoleni Local Municipality[65]

One of the emerging strategic elements of the Izinqoleni Municipality IDP is to promote ecotourism. The IDP is concerned about environmental resources that could possibly be degraded and ultimately reduce tourism development. Tourism is mainly concentrated around the Orbi Gorge corridor but before tourism can be expanded access to the hinterland regions needs to improve. An agritourism corridor exists within the Izinqoleni Local Municipality and is essential for development in the area.

Umuziwabantu Local Municipality[66]

Although the climate presents opportunities for tourism development in the Umuziwabantu Municipality, tourism is not yet established to its full potential. The area has potential for ecotourism as well as cultural tourism that needs to be marketed.

Umdoni Local Municipality[67]

One of the development objectives that the Umdoni Municipality will focus on over the next five years is tourism development. Ecotourism generates a large amount of income in the Umdoni local economy mostly due to coastal attractions such as estuaries, dunes and shores. Thus, if any of these attractions are damaged, tourism will decrease and the local economy will be significantly impacted. Since the coast is the main tourist attraction it is suggested that the coast needs proper management. The municipality has minimal inland tourism and tourism products other than the beach need to be developed such as the rural hinterland of the Greater South Coast. A challenge that a coastal municipality such as Umdoni might face in future is that of sea level rise and coastal erosion. However, the municipality has articulated a development strategy to use its coastal resources sustainably.

Hibiscus Coast Local Municipality[68]

Tourism is important to the Hibiscus Coast Municipality economy and it aims to increase economic growth and job creation through tourism development. Of all the tourist attractions in the district 67% are located in the Hibiscus Coast Municipality. The area has beautiful natural features as well as an appealing climate that attracts tourists all year-round. The municipality has 6 blue flag beaches that are of international standards. In addition the area has good infrastructure, amenities and facilities that can support tourism. For example, Margate Airport is located in the municipality which makes it easier for tourists to visit the area. The towns in the municipality are tourist oriented serving as recreational hubs over the holiday seasons. There is major tourism potential in the rural areas. The municipality is striving to create a world class experience for tourists with the budget value projected to be R158.5 million per annum.

Vulamehlo Local Municipality[69]

The tourism industry in the Vulamehlo Local Municipality is redundant due to the limited infrastructure and understanding of tourism in the area. However, the area has a high potential to develop a wide range of tourism products and contribute significantly to the local economy. In fact, one of the ways Vulamehlo aims to be economically viable by 2025 is through tourism. Ntshekombo is a potential tourism node as the area has tourism assets which can be further developed. Many tourist attractions in the area also need better marketing. The municipality has embarked on a number of tourism development projects to improve cultural tourism. There are activities such as quarries and borrow pits taking place that can impact the natural beauty of the area making it less attractive to tourists if not managed properly. When considering the future tourism growth in Vulamehlo it is important to protect the natural environment.

---

[65] Ezinqoleni Municipality IDP 2015/2016, http://ezinqoleni.gov.za/publications/municipal-idp

[66] Umuziwabantu Reviewed IDP 2015/2016, http://www.umuziwabantu.gov.za/portals/0/Documents/Notices/201516%20IDP%20Reviewed.pdf

[67] Umdoni Municipality IDP 2015/2016, http://www.umdoni.gov.za/docs/idp/2014/UMdoniIDP13-14.pdf

[68] Hibiscus Coast Local Municipality IDP 2016/2017, http://hcm.gov.za/HCM_Documents/IDP/HCM%20IDP%209-6-16%20FINAL.pdf

[69] Vulamehlo Municipality IDP 2015/2016, http://devplan.kzncogta.gov.za/idp_reviewed_2015_16/IDPS/KZ211/Adopted/Vulamehlo%20IDP%202015%2022-6-15%20low%20res.pdf

- **Tourism projection**

Ugu District Growth and Development Strategy highlights inadequate infrastructure maintenance and development as a potential driver of tourism decline in which coastal tourism infrastructure can be regarded as 'out of date' and in need of upgrading[70]. This decline may also be associated with the 'economic turmoil' experienced throughout the country[71]. It is however forecasted that tourism in the Ugu District Municipality will grow by 2-4% per annum[72]. The motivation for this projection is given due to Ugu South Coast Tourism (Pty) Ltd being established as a Municipal Entity by the Ugu District Municipality in order to promote tourism. Due to marketing efforts and campaigns such as the Sunny and Safe campaign, the district's tourism industry has been sustained.[73] Furthermore, there are tourism development initiatives that have been embarked in the district include the Craft Commercialisation Programme, promotion and support of sports tourism initiative,[74] Ntelezi Msani Memorial Project,[75] Kwa Qiko Execution Rock, development of Kwa Thoyana Game Reserve,76 as well as anchor projects at Tshehlope, Isintu Cultural Village, Ehluhluwe Kwa Tikwalala and Vernon Crookes Nature Reserve.

The Ugu Growth and Development Strategy binds all stakeholders to make the Ugu District a leading tourist destination by 203077. All the local municipalities are working towards achieving this goal.

[70] Ugu District Growth and Development Strategy: Final Report (December 2012), http://devplan.kzncogta.gov.za/idp_reviewed_2014_15/IDPS/DC21/Adopted/2012-12-03%20Ugu%20Growth%20and%20Development%20Strategy%20(Final%20Report).pdf

[71] Umdoni IDP

[72] Electronic Communication from Justin Mackrory CEO- Ugu SCT [14 July, 2016]

[73] Ugu South Coast Tourism (Pty) Ltd, Annual Report, 30 June 2015, http://www.southcoasttourism.co.za/Libraries/Annual_Reports/Annual_Report_2015.sflb.ashx

[74] http://www.localgovernment.co.za/districts/view/19/Ugu-District-Municipality#economic-development

[75] http://www.umzumbe.gov.za/

[76] http://www.kzncogta.gov.za/Portals/0/Documents/municipal_management/IDP_REVIEWED_2009_10/IDPS/KZ211/Adopted/Vulamehlo%20L%20M%20LED%20Turnaround%20document.PDF

[77] Ugu District Growth and Development Strategy: Final Report (December 2012), http://devplan.kzncogta.gov.za/idp_reviewed_2014_15/IDPS/DC21/Adopted/2012-12-03%20Ugu%20Growth%20and%20Development%20Strategy%20(Final%20Report).pdf

3 Climate Analysis

3.1 Background

Climate is the overarching generalised long term set of atmospheric, ocean and land cover conditions that provide the bounding context for the occurrence and likelihood of meteorological events experienced within a localised area. As such, when considering the likely climate changes first and foremost at a local scale will prove ineffectual. The approach that should be undertaken is the assessment of the general large scale climate change as the anomaly baseline. From this large scale anomaly climate, assessment should then account for the factors influencing local weather variability such as topography, landuse, synoptic influences and ocean currents, and how the large scale change may be manifest on a more specific footprint scale. The data used for the analysis of the climate parameters such as heat waves or changed precipitation profiles is downscaled from the IPCC AR5 models to an approximately 45km x 45km grid while additional spatial resolution is garnered from the SimClim data which takes into account the locally influencing climatic factors to a scale of 5km x 5km.

Adaptive response must be undertaken in accordance with the projected changing climate parameters. This chapter presents an overview of the meteorological climate changes that are likely to occur over Ugu DM over the next four decades. The modelling is done with the aim of informing the decision-making processes.

The scale of the future climate impacts will vary based on the anthropogenic mitigation of factors responsible for currently experienced changes. The mitigation scenarios account for several variances of potential global economic and environmental development and are quantified as the Representative Concentration Pathways (RCP). The four RCP scenarios depicted in Table 7 are estimated concentrations of CO_2, CH_4 and N_2O based on a combination of assessment models, global carbon cycle, and atmospheric chemistry and climate models. They also integrate assumed land use changes and sector-based emissions of greenhouse gasses (GHGs) from present day levels. These present GHGs include the sectoral assessment of energy supply, industry, transport, and buildings with contributions of 47%, 30%, 11% and 3% respectively.[78]

[78] IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Table 7 Representative Concentration Pathways

	CO2 (ppm)	CH4 and N2O (ppm)	Resulting radiative forcing (W.m-2)	Scenario
RCP 2.6	421	54	2.6	Best case
RCP 4.5	538	92	4.5	Best case - Medium scenario
RCP 6.0	670	130	6.0	Worst case - Medium scenario
RCP 8.5	936	377	8.5	Worst case

These RCPs were used as input for the coupled model ensembles of the IPCC Assessment Report Five [79](AR5).These RCPs show the change from pre-industrial insolation watts per m² resulting from the emissions. RCP 2.6 represents the mitigation scenario leading to a very low forcing level – best case – emissions stabilise from 2010 – 2020 and decrease thereafter (best case scenario with global focus on the environmentally sustainable practices). RCP 4.5 – likely best case – emissions stabilise from 2040 and decrease thereafter. RCP 6.0 – likely worst case – emission stabilise from 2080 and decrease thereafter. RCP 8.5 represents the very high greenhouse gas emission scenario – emissions don't stabilise, worst case scenario with a focus on economic advancement at the expense of environmental sustainability. These emission scenarios give light to the varying potential climatic futures based on human development goals in the present and near future.

Using climate projection data requires the acknowledgement of various uncertainties. The IPCC projections rely on forty different GCMs with different accuracies forecasting to the varying RCP scenarios. These RCPs are themselves estimates of potential future thermal forcings as informed by adherence to emission policies and potential future technologies. The downscaling of the IPCC data required robust constraining parameters to present a more accurate local projection. In areas where observational data is limited, these constraining parameters have increased uncertainty. Results obtained and recommendations made based on these data should be used as a guideline to adapt/mitigate to a potential future climate rather than a definitive one. This is particularly prevalent when noting the significant disparity even in the current variability of rainfall regimes. This is influenced by things like topography, wind, vegetation and even ocean currents. Beyond that, a further layer of complexity is added with looking at rainfall intensity, diurnal and seasonal onsets before accounting for short and long term influences such as the diurnal, seasonal, inter annual cycles, the ENSO cycles as well as decadal changes. When projecting precipitation changes into a semi unknown future these uncertainties are further exacerbated.

The projection parameters are therefore presented in terms of a probability of changes highlighting the most likely range of precipitation experienced in the future. The probabilities also allow for the possibility of more extreme anomalous occurrence of events in both directions i.e. probability of more extreme rainfall days as well as less extreme rainfall days. Statistical probability analysis of the climate data is undertaken on the variables of maximum temperature, minimum temperature, precipitation, among others. The observational data sets used include;

[79] IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

- Climate Research Unit - CRU TS v3.23 at 0.5°x0.5° spatial resolution and monthly temporal resolution from the year 1901 to 2014.
- National Oceanic and Atmospheric Administration - National Centers for Environmental Prediction – NOAA NCEP CPC 0.5°x0.5° spatial resolution and monthly temporal resolution from the year 1960 to 2016.
- National Oceanic and Atmospheric Administration - National Centers for Environmental Prediction – NOAA NCEP CPC African Rainfall Climatology, satellite based observations at 0.1°x0.1° spatial resolution and daily temporal resolution from the year 1983 to 2016.
- SimClim IPCC historical downscaled data 5x5km spatial resolution monthly temporal resolution from the year 1995 to 2015.
- Swedish Meteorological and Hydrological Institute – SMHI Cordex CMIP5 historical experiments at 0.5°x0.5° spatial resolution and daily temporal resolution from the year 1951 to 2005

The projected datasets used include**;**

- SimClim IPCC AR5 downscaled data 5x5km spatial resolution monthly temporal resolution from the year 2015 to 2100.
- Swedish Meteorological and Hydrological Institute – SMHI Cordex CMIP5 IPCC AR5 projected experiments at 0.5°x0.5° spatial resolution and daily temporal resolution from the year 2006 to 2100 for the 9 IPCC climate models used in AR5.

There is currently a dearth of locally sourced climate change data available. Organisations such South African Weather Services (SAWS) are in the process of building a climate data portal to address this shortfall, yet the model data they will be sourcing is the SMHI cordex data utilised in this study. Research institutions such as the Climate Systems Analysis Group (CSAG) based at the University of Cape Town are the African leaders of the CORDEX simulations and have a Climate Information Portal presenting the climate information along with an interpretive description to better convey understanding. While their downscaling methodologies are unique and account for local scale climate factors, the underlying model data utilised is that of the IPCC suite of models. There does not currently exist a South African developed climate model that is able to simulate the coupled global atmosphere ocean relationship to the extent to which existing international GCMs are able.

3.1.1 Natural vs Anthropogenic Climate changes

It must be acknowledged that there are natural cycles that will change the climate over time. However the long term impacts and earths capacity for system reversibility of natural vs anthropogenic climate changes vary significantly.

Long term natural changes include cosmic influences such as Magnetic field changes (averaging 450 000 years, impacting UV filtering) and the Milankovitch cycles; Eccentricity, Axial tilt and Axial precession. These changes act on the order of 125 000, 41 000 and 26 000 years respectively and will alter the ice age onset and retreat. Terrestrial influences include carbon cycling which changes on the order of seconds to minutes (photosynthesis), in terms of years, decades and centuries (decay and release of organics), and thousands to millions of years (formation of natural gas, oil and coal), which impacts atmospheric CO2 presence and subsequently the global greenhouse effect. Changes in the

Oceanic thermohaline circulation occurs in the order of thousands of years and normally require a triggering event to have any lasting consequence[80] such as alterations to ocean global heat transport.

Short term natural changes include the land surface change such as natural desertification or vegetation migration. This will have a variable time frame of change but can be as quick as a few years in extreme scenarios, these changes impact surface reflectivity and moisture uptake in plants. Solar activity changes in the order of approximately 11 year time scales impacting the amount of incoming solar radiation. Other events include earthquakes, ice melt events, and volcanoes which can very quickly alter the land surface vegetation, albedo and atmospheric composition resulting in rapid but often short lived climate changes.

Natural climate change processes are unavoidable but the most significant climate drivers act over extremely long time frames (several thousand years or more). The changes are also cyclical in nature and therefore the impacts oscillate about the mean climate over time and do not depict irreversible trends long term.

Anthropogenic climate change (introduction of fossil fuels to the atmosphere and land surface changes) is the altering of the climate system at a rate and with a persistence that is not observed in the natural system. This climate change presents long term trends with no oscillation (return to normal state over time). The impacts of anthropogenic climate change is altering ecosystems and sensitive environments beyond the normal thresholds and transforming areas into an irreversible state. This climate analysis and strategy focuses on anthropogenic climate changes.

3.1.2 Climate change in the South African context

Climate change in South Africa shows projected rainfall variations (Figure 38 (i)) with a distinct gradient of increasing to decreasing precipitation going east to west over the country. The increase in precipitation over Kwa-Zulu Natal and the north eastern parts of the Eastern Cape is caused partially by the enhanced evaporation from the warm Agulhas current and orographic influence of the Drakensberg mountain range. The areas of Northern Cape and Western Cape will experience less rainfall. There is a marked increase in both day and night time temperatures (Figure 38 (ii) & (iii)) with the most major change toward the inland regions of the country. Temperature increases are still present in areas closer to the coast but are reduced by the mitigating influence of the large bodies of water.

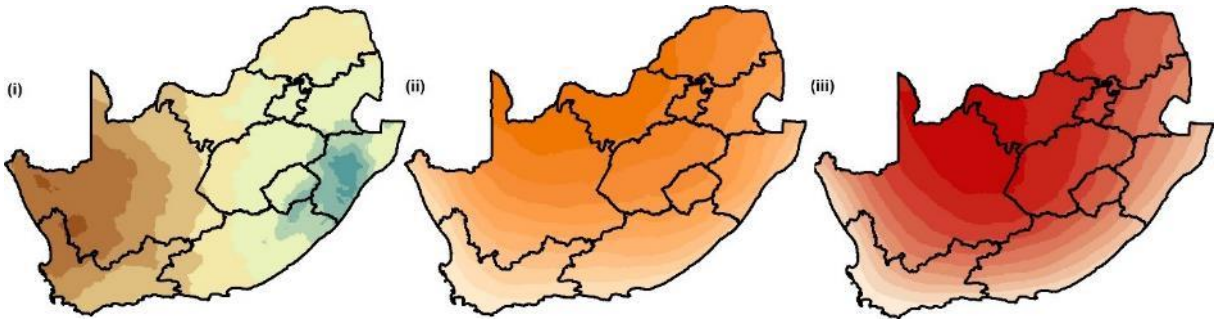


Figure 38: Spatial anomaly pattern. RCP4.5 2050 anomaly from climate baseline. (i) precipitation; more rain(blue), less rain (brown), (ii) night temperature; darker orange (warmer), (iii) day temperature; darker red (warmer)

These large scale changes will have dramatic influences on varying meteorological parameters. It is projected that there will be an increase in the number of days exhibiting extreme day time temperatures;

[80] Younger Dryas, influx of fresh water into the gulf stream due to melting glaciers in North America inhibiting subduction of water in the north Atlantic causing a short lived ice age in Europe.

as well as the number and duration of heat wave events. Furthermore, a greater number of warm nights will increase general discomfort, reduce overnight frost and morning dew.

The rainfall parameters are more complex but there is general agreement that areas where either increasing or decreasing rainfall volumes are expected, rainfall will be focused into a shorter timeframe. Some areas are exhibiting a shifting in the rainfall onset and cession timing. The rain season is decreasing in length; in the frontal areas of the western and southern areas of the country, winter rainfall is compressed and the dry summer is extended; to the east and north, the convective rainfall is clustered into fewer summer months and the shoulder seasons of autumn and spring exhibit more summer like temperatures and reduced rainfall. While it is generally expected that there will be a decrease in the number of rainfall days each year, it's highly likely that there will be an increase in precipitation intensity and the occurrence of more extreme events when it does rain. This is particularly true in the summer convective rainfall areas. There will also be an increase in dry spell duration between rainfall events.

3.2 Ugu District Municipality climate analysis

Climate status:

The climate of Ugu DM can be categorised into three distinct climate zones (Figure 39). These are coastal, inland north and inland south.

- The coastal climatology is influenced largely by the proximity to the warm Agulhas Ocean current. The thermal heat retentive capacity of the ocean reduces the diurnal temperature range and thus results in more mild temperatures along the coastal areas (Figure 42). The warm ocean current along the eastern coast provides water that is more predisposed to evaporation. Coastal areas therefore experience high humidity and significantly more precipitation (Figure 41) than inland and west coast areas.
- The inland climate zones do not receive the mitigation effect of proximity to the ocean and therefore have a larger diurnal temperature range. This is particularly noted in the northern inland areas which as the highest annual average daytime temperature. The inland southern areas partly cover higher altitude areas and will therefore have a reduced annual average temperature (Figure 42) with increased altitude inland. The precipitation profile is very similar between the inland northern and southern areas and both exhibit reduced precipitation from that which is noted toward the coast (Figure 41).

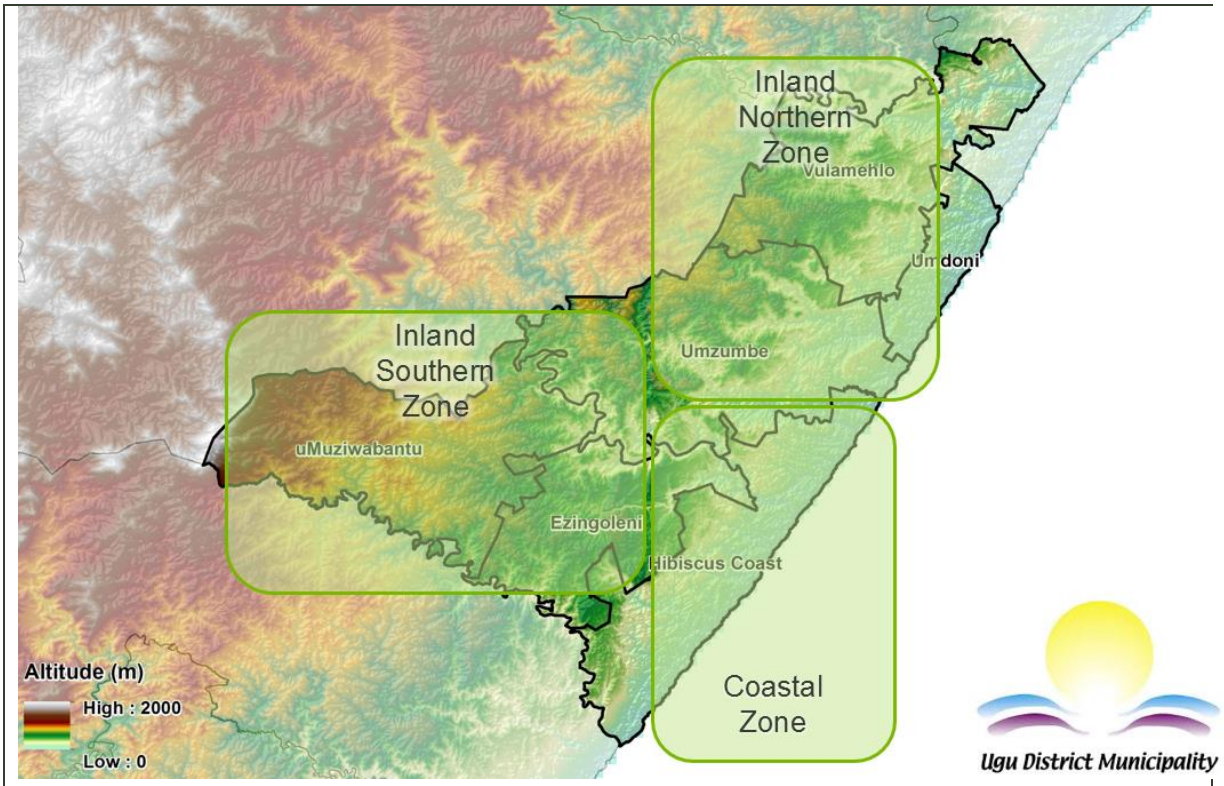


Figure 39: Three distinct climatic zones, Coastal, Inland north and Inland South

Climate changes influences:

The climate system is a balance of varying thermal, pressure and moisture characteristics of the atmosphere and ocean. Insolation (incoming solar radiation) travels through the atmosphere, largely unobstructed and warms the earth and ocean surface. The heat is re-radiated upwards in the form of long wave terrestrial radiation to the atmosphere. Fossil fuel emission increases through development from pre-industrial levels have resulted in increased levels of greenhouse gasses resident in the atmosphere. The fossil fuel emissions trapped in the atmosphere strongly absorb the longer infrared wave lengths of terrestrial radiation, particularly CO2, N2O and water vapour. The absorbed heat is re-emitted in all directions, including back down to earth, where it is re-absorbed by the earth surface and re-emitted again, therefore keeping the heat in the system. These gases are found naturally in the atmosphere and make our planet warm enough for us to survive, however the additional CO2 and N2O have increased at a rate beyond what the atmosphere and the carbon system can recycle, such that what has been emitted has increased the heat adsorption of the atmosphere.

Temperature differentials and balancing of the thermodynamic gradient in the atmosphere are the driving forces behind global short term weather as well as long term climate. Therefore the change noted already in the baseline temperature will have dramatic effects in all aspects of the meteorological system. The temperature change alters the global pressure systems which in turn impacts air circulation, winds, atmospheric moisture, ocean currents and rainfall distributions. As this is an open system not limited by country boundaries, the non-polluter suffers with (sometimes more than) the polluter. Simply put, this is causing the increase in temperatures globally and the changes to the short term meteorology and the subsequent climate base lines. The changes experienced are not uniform in space and time. There is both spatial and temporal variation in the impacts associated with climate change.

Basin assessment:

Precipitation and water availability is paramount to the communities, agricultural areas and natural vegetation within Ugu. Catchments however do not follow administrative boundaries and therefore a cursory assessment of the river basin the feeds the rivers going through Ugu is needed.

The upper catchment to the north west of the Mvoti to Umzimkulu basin contributes significant volume of Ugu's rivers. There many dams located in this area due to heightened rainfall volume and high relief. Closer to the coast there is also significant rainfall and a few dams are also present in these areas however this contribution doesn't extend along the full catchment. The anomalous RCP4.5 precipitation scenario depicts an increase in the annual average volume of approximately 1% (Figure 40). The projected years of 2050 and 2060 show a very similar spatial distribution. This increase will aid in feeding the rivers in the basin. It should however be noted that the projected rainfall events will likely be of shorter duration and more intense events and therefore peak discharges in the lower courses of the river will likely increase. It will also place additional pressure on dam infrastructure by quickly reaching or exceeding capacity and then a discharge may be required. There will however be a long duration between rainfall events and therefore water stress is likely to remain.

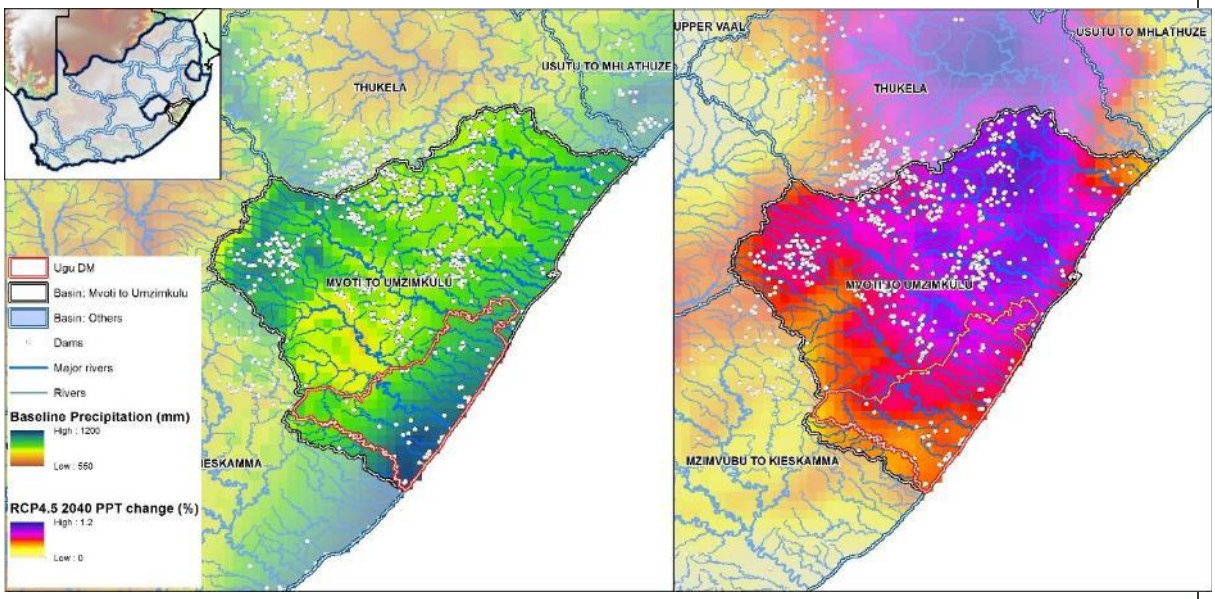


Figure 40: Mvoti to Umzimkulu Basin. Observer Precipitation left, RCP4.5 2040 anomolus precipitation (%)

Increasing annual rainfall

The majority of Ugu's precipitation occurs along the coast and to the south, with slightly less seen inland (Figure 41 - left). There is also significant variability in the same month between years, particularly in late summer (Figure 41 - left). Climate change under RCP4.5 shows a very slight increase (<1%) in annual average precipitation over Ugu (and along the eastern side of South Africa) with the majority of change noted to the north east of the district (Figure 42 - left). The monthly variability depicted by the monthly envelope (Figure 42 - right) shows the range of one standard deviation from the mean monthly rainfall. The anomaly bars show the change from mean in mm per month for the decades 2020's, 2030's, 2040's and 2050's. Increased precipitation volumes are seen in late spring and early summer, while decreased values are shown in the mid to late summer months. The anomaly is suggesting an overall average potential shift in the rainfall regime to occur earlier in the year than has been observed previously impacting agricultural seasons. This change will likely find a new equilibrium and stabilise with a flattening of the peak precipitation to encompass the earlier months.

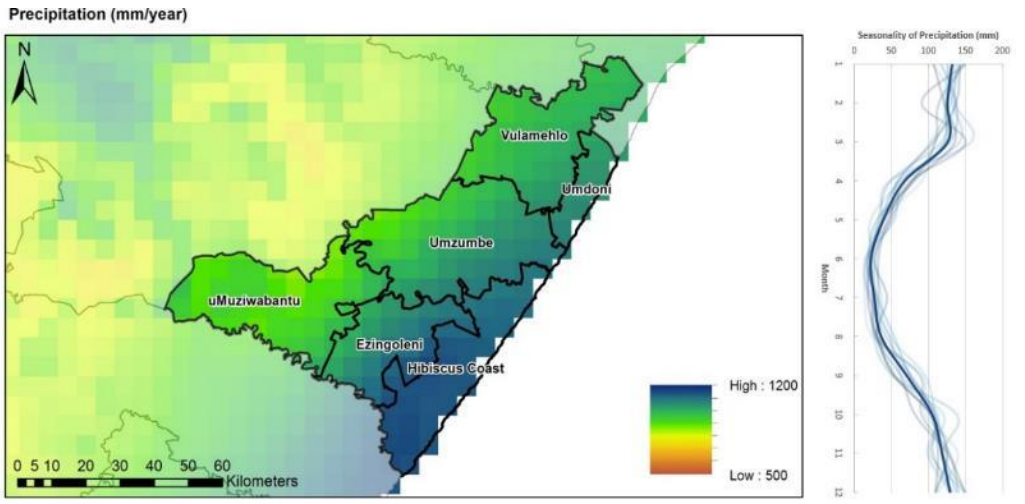


Figure 41: Observed precipitation and monthly variability over Ugu DM

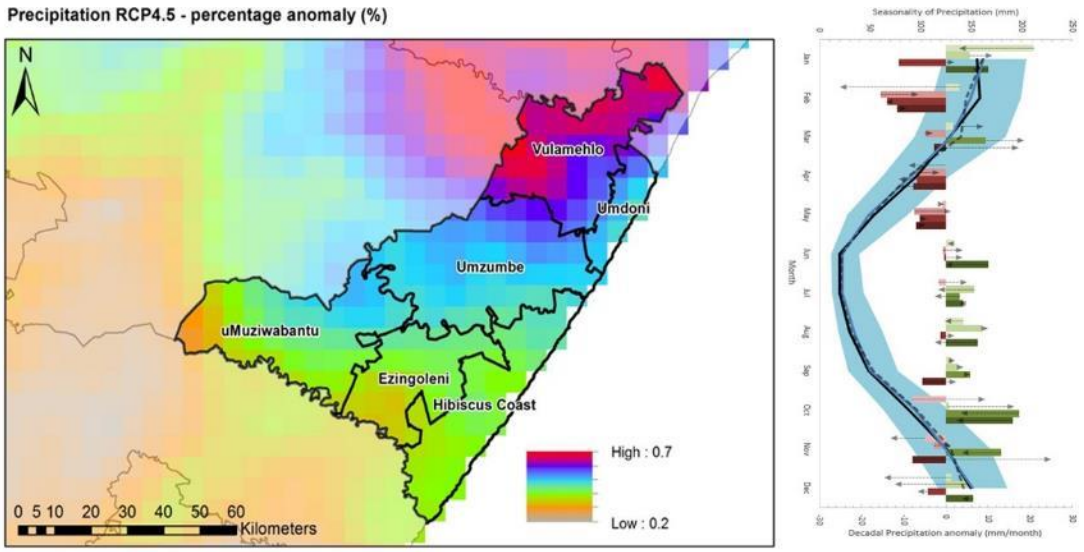


Figure 42: RCP4.5 Projected and anomalous future precipitation over Ugu DM

Increased summer rainfall intensity

The number of rainfall days (>0.2mm/day) is remaining mostly consistent across the three climate zones with the peak during the summer months of December, January, February (DFJ), followed by the spring months of September October November (SON), Autumn; March, April, May (MAM) and lastly winter; June, July, August (JJA) with the fewest rainfall days (Figure 43– top). The projected likely number of days (both lower likely and upper likely), which correlates to the 40th to 60th percentiles, matches well with the past number of rainfall days.

Assessing the more extreme rainfall days (>35mm/day) however shows an increase in the likely occurrence of these higher magnitude days during summer along the coastal areas (Figure 43– bottom). The other areas place the likely range within the past observed number of extreme events range (see Appendix - Figure 85). Though however extreme events are most likely to occur within this "likely range" over different years, it is possible that there can be a number both above and below this range and vary between years.

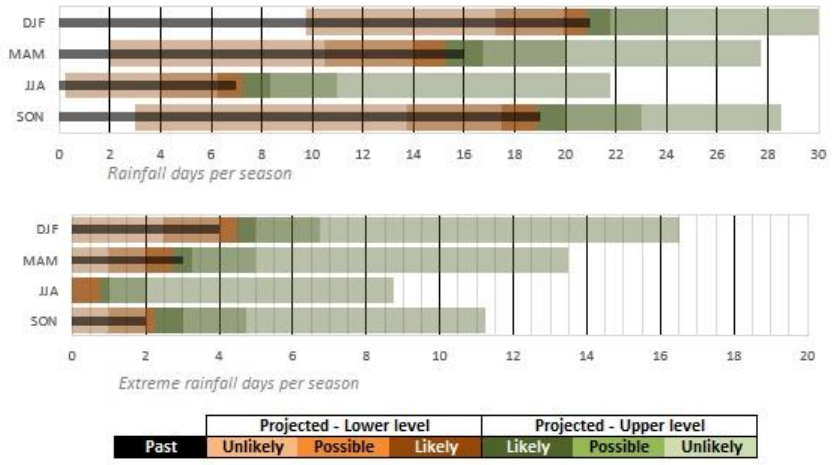


Figure 43: Number of rain days (top set) and extreme rainfall days (bottom set) per season for Coastal area

The precipitation profile) depicts the occurrence frequency of different magnitude rainfall events. The coastal area (Figure 44 – top) has the highest likelihood of larger magnitude events over all seasons. The summer and autumn months in each area show a similar profile to each other, although summer months show a shift towards more likely higher threshold events in the future than was previously observed (see Appendix - Figure 86 – top set). The remaining rainfall thresholds in the seasonal profile are also increased. The autumn months don't show as clear a trend over all the stations. Winter and spring months appear to have a dampened profile in the future

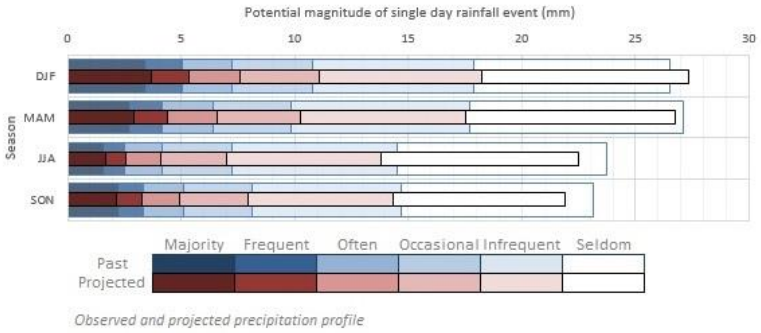


Figure 44: Past and projected Rainfall Profile of the Coastal areas

Increasing rainfall variability

The precipitation climate graph (Figure 45) in the future is shown to take the same general shape in the future as that which was observed in the past climate, however there are monthly departures from the mean climatology indicating a potential variability range in future decades. These anomalies vary significantly in each area and hardly present a unified direction of change over subsequent decades in the same month when looking at each climate zones' precipitation climate graph (see Appendix - Figure 86 – bottom set).

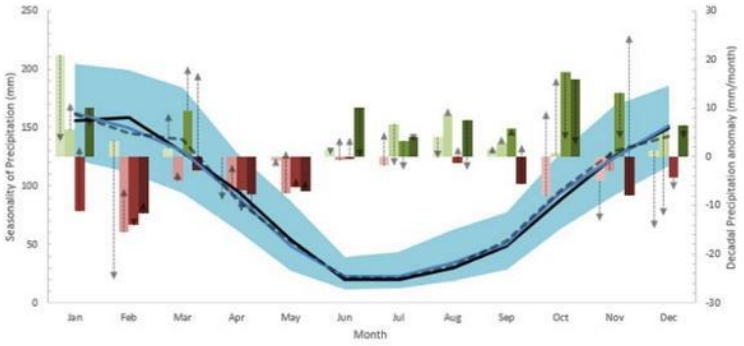
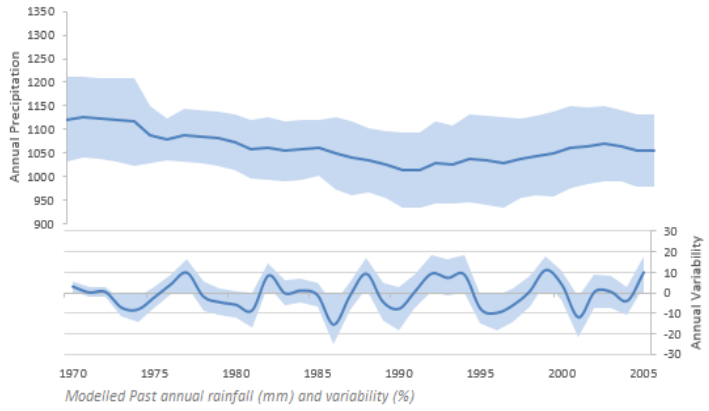


Figure 45: RCP4.5 projected monthly anomaly from monthly mean per decade 2020, 2030, 2040, 2050 (bottom set : green and red bars, black arrows represent RCP8.5) for Ugu DM

Assessing the time series of precipitation from the three climate zones shows variation over time in the annual precipitation volumes over the observed period (Figure 46 – top set) and projected future (Figure 46– bottom set). The standard deviation presents the range of possible annual precipitation volumes that could be considered within a normal range. The annual variability is shown for each climate zone for past and future volumes (see Appendix - Figure 83), represents the potential change between consecutive years from a 5 year rolling mean volume. For example in the past coastal data there is a variability of -13% in 1986 and +9% in 1988 (Figure 46– top set). This is a turnaround of 22% in total yearly precipitation over just 2 years. Slightly smaller ranges are noted in the inlands past variabilities. While there is no significant change in the projected future variabilities, there are more direction changes between positive and negative shifts from the annual mean in a shorter time. The variability direction shift is increasing meaning greater disparity in annual precipitation over a shorter time frame.



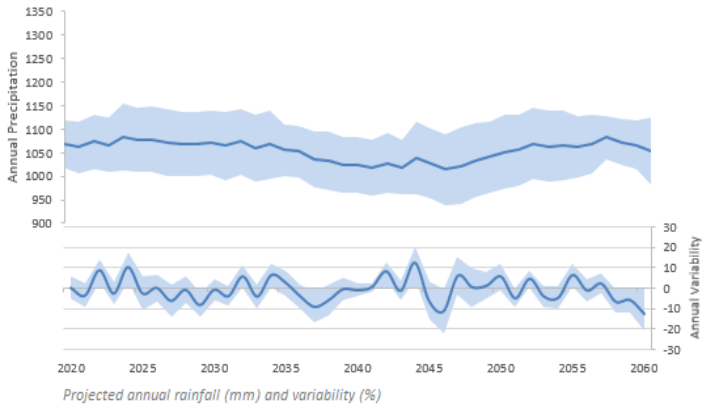


Figure 46: Annual average precipitation volumes and yearly variability potential for Coastal area, Modelled past (top set), RCP4.5 Projected future (bottom set)

The variability is a measure in mm away from climate mean each month simulates in the past and for the future climate under RCP4.5 (Figure 47). The greater the distance from the radial centre, the more variability from mean. The highest variability is focused in the late summer months of February and March for each of the climate zones. The coastal zone shows the most variability of all the zones followed by inland north and inland South with the least variability (see Appendix - Figure 84). The variability is higher in the projected future data for each of the climate zones; all with a focus of variability in the late summer months. The greater variability in the future is due in part to a warmer atmosphere under climate change conditions, being able to retain an increased moisture volume and needing greater cooling before condensation (and precipitation) occurs. This is also why there is a greater dry spell duration and more intense, shorter rainfall events.

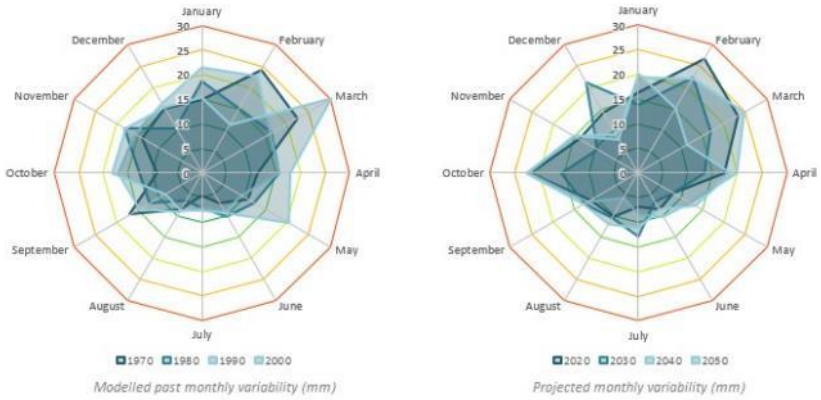


Figure 47: Monthly variability potential (mm volume) for Coastal areas, Modelled past (left), RCP4.5 Projected future (right)

Drought potential

Figure 48 shows the yearly total (top pf each set) and seasonal (bottom of each set) percent departure from past results. Again it is shows the low likely (dark brown) and high likely (dark green) ranges as well as possible and unlikely but still possible ranges. In a drought year the total precipitation is -33% or less than the climatological mean. Where the low likely and high likely ranges (darker shades) are below the 0% (past average), this will indicate an enhanced drought potential. One such incidence is the lower values for the likely range noted in the 2030's (in all areas) which expresses that the potential for drought is higher. The lighter "possible range" variability can occur without being a climatological anomaly. Therefore future planning should certainly account for the depicted possible range which is approximately -20%.

What can be noted further is the seasonal discrepancies (bottom of each set) which shows a mild increase in likelihood over the past for DJF; there is also a likelihood that below observed volumes will be present in MAM and SON impacting the shoulder seasons. The reduced rainfall in JJA months biases the change from mean to show large disparity in potential volumes.

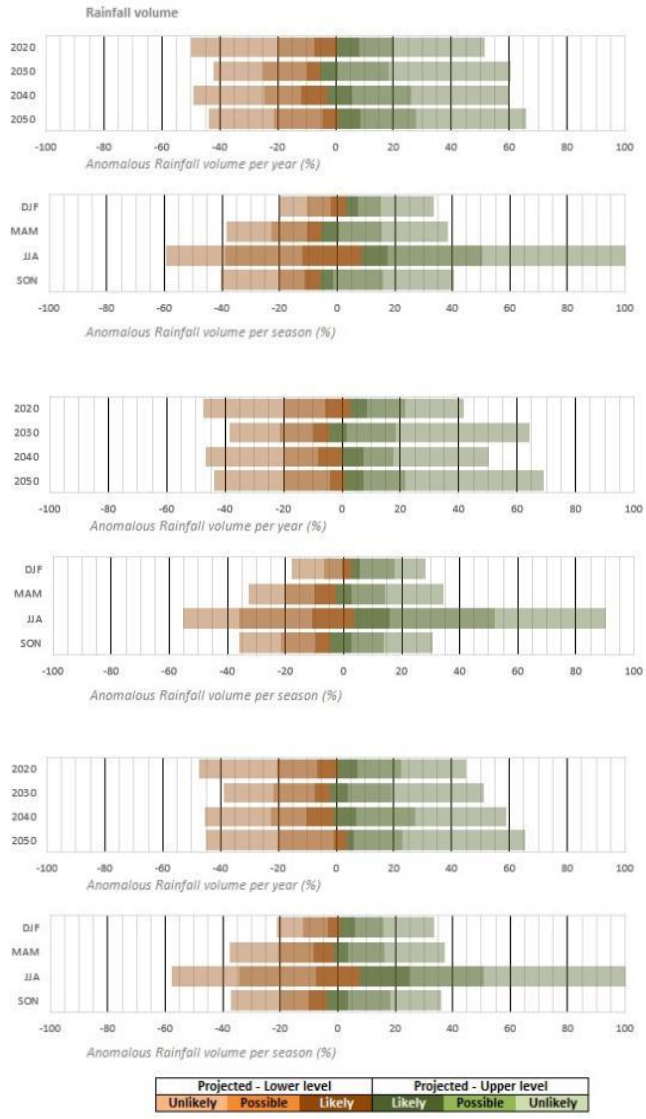


Figure 48: Potential future decadal (top of each set) and seasonal (bottom of each set) anomaly for each climate zone, Coastal (top two panels), Inland South (centre two panels) and Inland North (bottom two panels)

Spatial temperature increases

The spatial average temperature profile for Ugu DM (Figure 49 - left) shows increased temperatures to the north (Vulamehlo, Umdoni) and inland areas (Umzumbe) of the DM. The higher elevation areas show a decreased average annual temperature, while the southern inland and coastal areas show more mild temperatures (Ezingoleni, Hibiscus Coast). There is some variability in yearly temperature profiles (Figure 49 - right) however the profile remains mostly consistent and has minimal monthly variation from the mean.

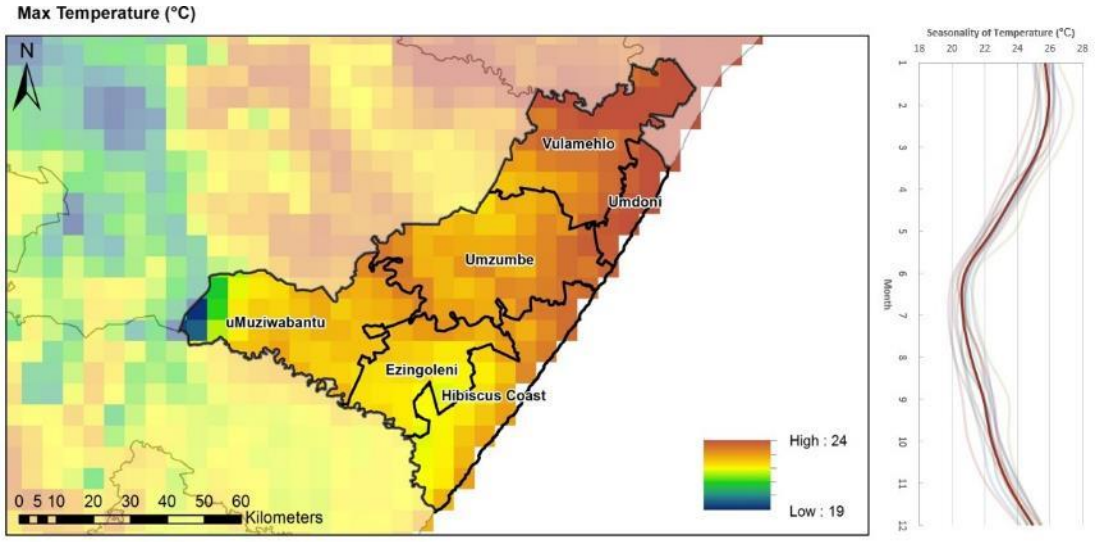


Figure 49: Observed day time temperatures over Ugu DM

The projected temperature anomaly show a uniform temperature change cross -section from the coastal to further inland areas (Figure 50 - left). The coastal areas exhibit the smallest temperature increase (+0.7°C) due to the ocean mitigation effects. While further inland there is a larger anomaly from the present day mean temperatures (+0.8°C). This profile is at the year 2030 under the RCP4.5 scenario. Years projected further into the future and under RCPs 6.0 and 8.5 will show significantly higher anomalies. The projected monthly profile (Figure 50 - left) shows the monthly temperature profile increased under RCP4.5 and RCP8.5 as well as the decadal increases in the monthly anomalies.

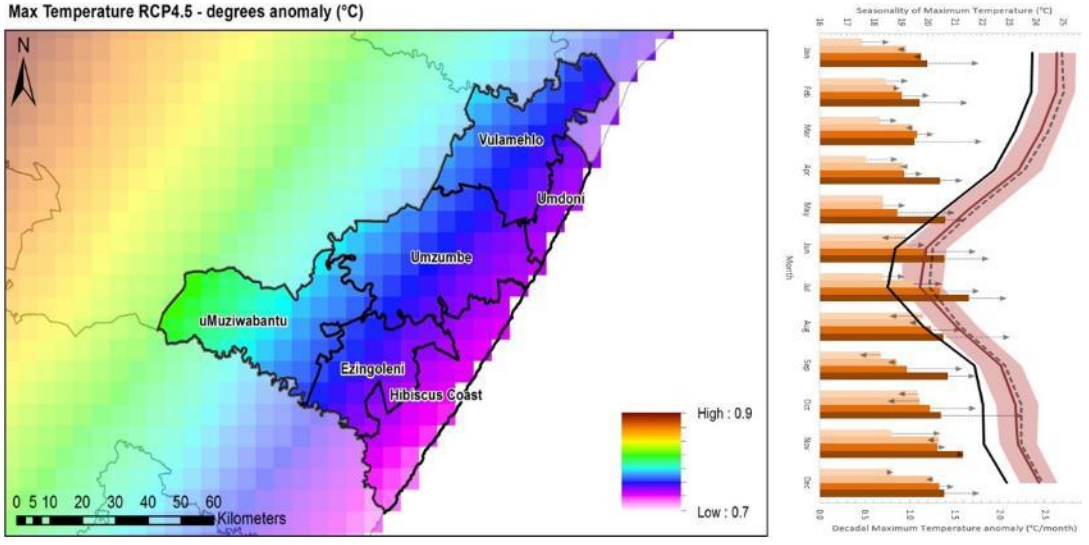


Figure 50: Projected (RCP4.5 - 2030) temperature spatial anomaly (left), monthly temperature profile black line (past), red line (projected RCP4.5), dashed line (projected RCP8.5), decadal anomaly bars for 2020's, 2030's, 2040's, 2050's for RCP4.5, arrows (RCP8.5)

Increase of temperature profile for day and night time

The general increase in average temperatures will change the probability occurrence of all temperature thresholds. The highest frequency events has shifted from 22°C in the 1960's to present day and is projected to be over 23°C by 2050 (Figure 51 - right) in the Inland north area. Other areas follow similar progression over time.

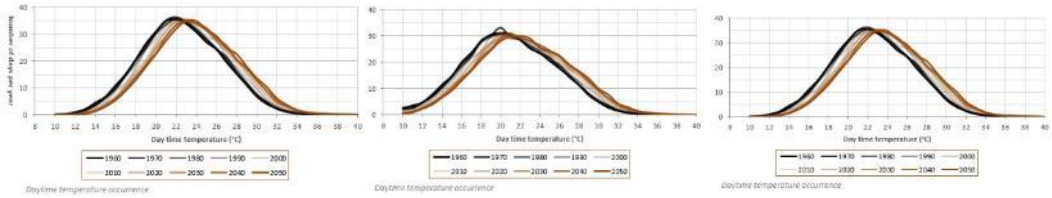


Figure 51: Temperature profile shifting over time for coastal (left), Inland South (centre) and Inland North (right) climate zones.

This increase is not uniform across all months. The retention of atmospheric heat will increase the heating effect of the cooler winter months more than the already warm summer months. The Inland north area shows anomalous temperatures in summer (December, January and February) of approximately 1°C from the warm past temperatures (Figure 52). The winter months (June, July, August), having a lower average temperature experience the increased atmospheric temperature to a greater extent and show anomaly of 1-1.5°C. Other climate areas exhibit a similar wintertime anomaly.

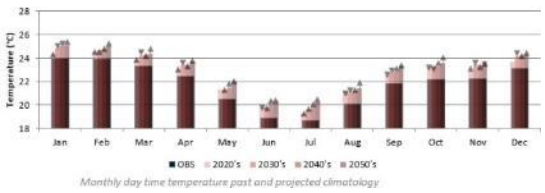


Figure 52: Inland North anomalous projected temperature changes for 2020's, 2030's, 2040's, 2050's (lighter red bars), from the past temperatures (dark bars) for RCP4.5, arrows show further change under RCP8.5

Night time temperature profile is similarly affected (Figure 53). The most observed temperatures (40th to 60th percentile) shift from the range of 6°C – 9.5°C to the range of 7.4°C – 11.5°C for Winter months (when the cooler land is heated to a greater extent by the warmer atmosphere) in the Inland North area. This same trend is noted in the other seasons, but to a lesser degree of change.

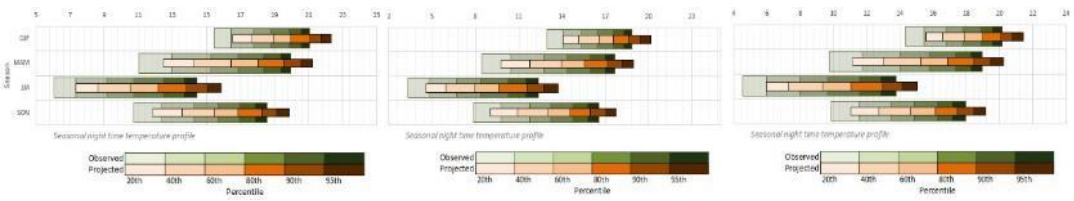


Figure 53: Night time temperature profile, past (green shades) and projected RCP4.5 (future orange shades) for Coastal (left), Inland South (centre) and Inland North (right)

Increased heat waves and extreme temperature days

As the entire temperature profile is shifting towards higher average day and night time temperatures, it is expected that there is a significant increase in the number of summer time heatwave events (5 days or more of higher than average monthly temperature). By the middle part of the century, there will likely be approximately 40% more heatwaves per year than was experienced in the period 1990 – 2000 for the Inland North areas (Figure 54). Other areas will follow this trend, however the Inland North areas experience the highest average temperatures and therefore the heat waves will be more extreme in those areas than in others.

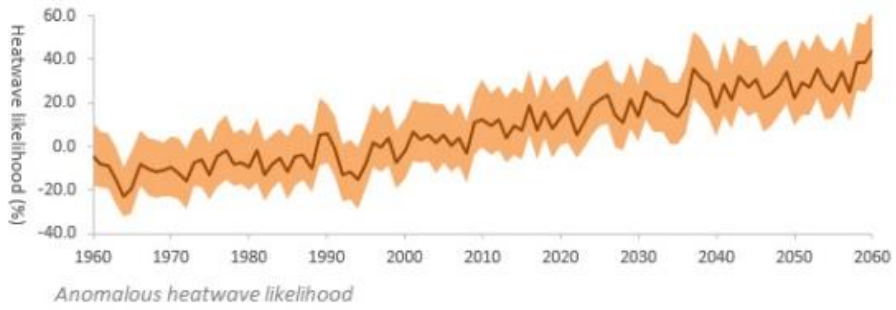


Figure 54: Anomalous change over time (from 1990-2000) of heatwave likelihood for the Inland North areas from RCP4.5

The shift of the temperature profiles and in the presence of higher likelihood of heat waves, the occurrence of extreme temperature days (+35°C) is set to increase (Figure 55). These extreme days are noted in the Spring and Summer seasons for the three areas and are likely to occur at least twice and potentially more than four times in summer in the coastal and Inland north areas. Spring months also show an increase in occurrence but to a lesser extent than is noted in the summer months. The Inland South areas also shows an increased number of events in summer and spring but this change is not as significant as is noted in the other areas.

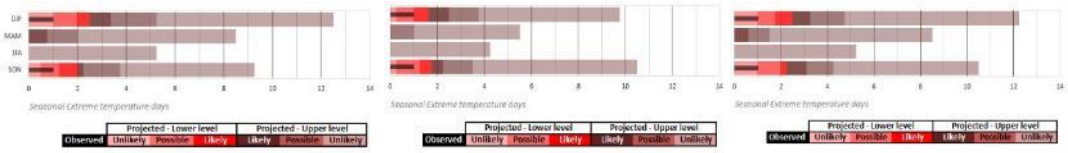


Figure 55: Number of extreme temperature days per season, past (thin bars) and projected RCP4.5 (thick red bars) for Coastal (left), Inland South (centre) and Inland North (right)

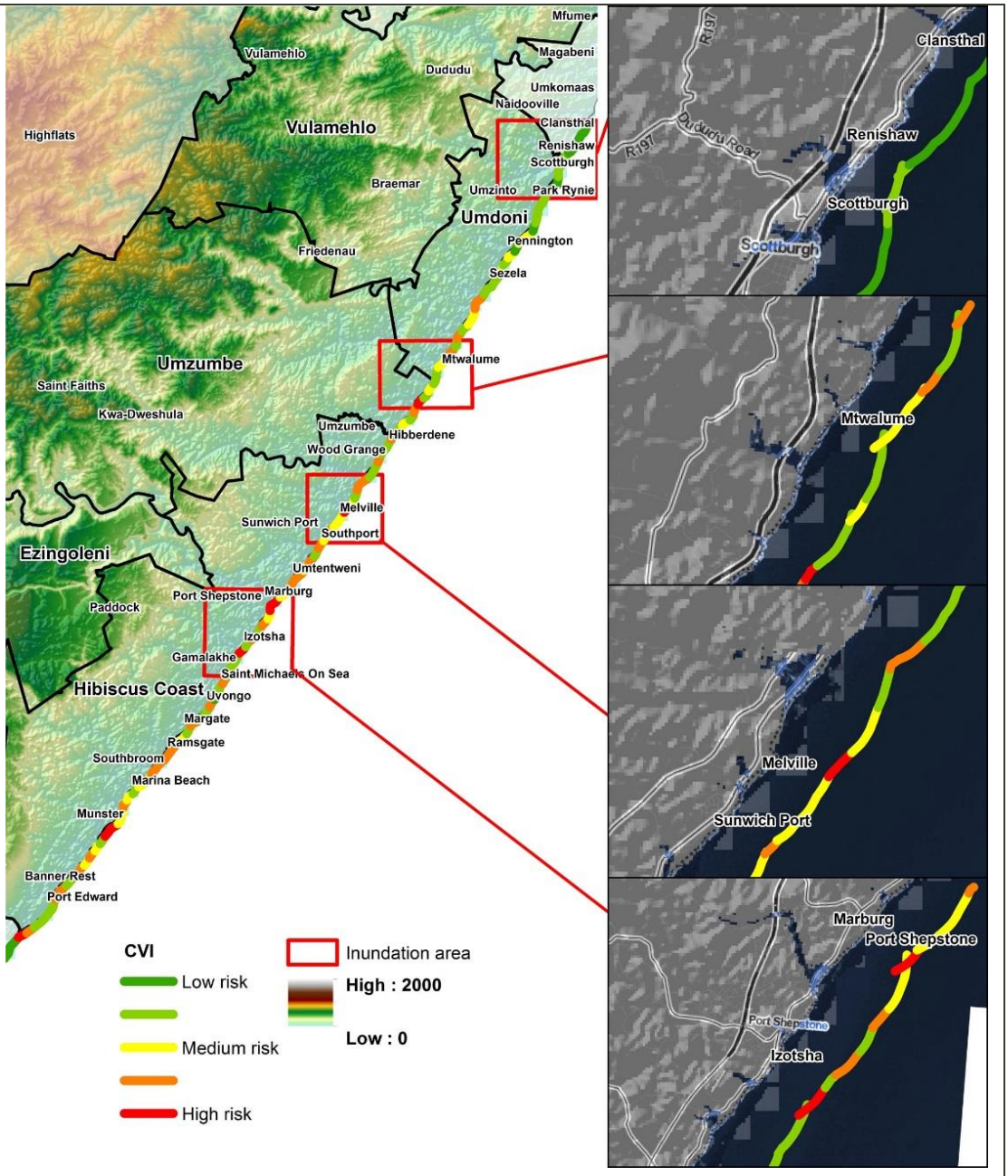


Figure 56: Areas projected to be impacted by Sea-level rise under the RCP8.5 scenario

Sea level will increase the inundation and saline intrusion risk to low-lying coastal areas. Also at risk are estuaries and river mouth areas. The increase in ocean storms that is projected to take place in the Indian Ocean will drive heightened storm surges that when exacerbated by rising sea level could damage areas of lower elevation and rivers. The damage caused may result in loss of land as well as ecological damage and risk to community livelihoods. Figure 56 indicates areas and infrastructure that are at particular risk from the impacts of sea-level rise.

Seasonal spatial changes in Temperatures and precipitation

Spatial Climate Changes are projected to be heightened further inland of the DM for both day and night time temperatures (Figure 57). The changes are slightly more prominent in the autumn and winter season, particularly for minimum temperatures. The rainfall is set to increase in all season for the full DM other than in winter in the very western inland areas which will see a decrease in precipitation. The highest increase in precipitation is noted in the northern areas in spring but in summer it's roughly a consistent increase. These changes are likely to be enhanced the further into the future projections are done, particularly for future temperatures. Precipitation volumes are less certain though all studies are predicting an increase in the precipitation volume on the east coast of south Africa going into the future. How that will be manifest in terms of spatial variability, extreme events and seasonality is less certain.

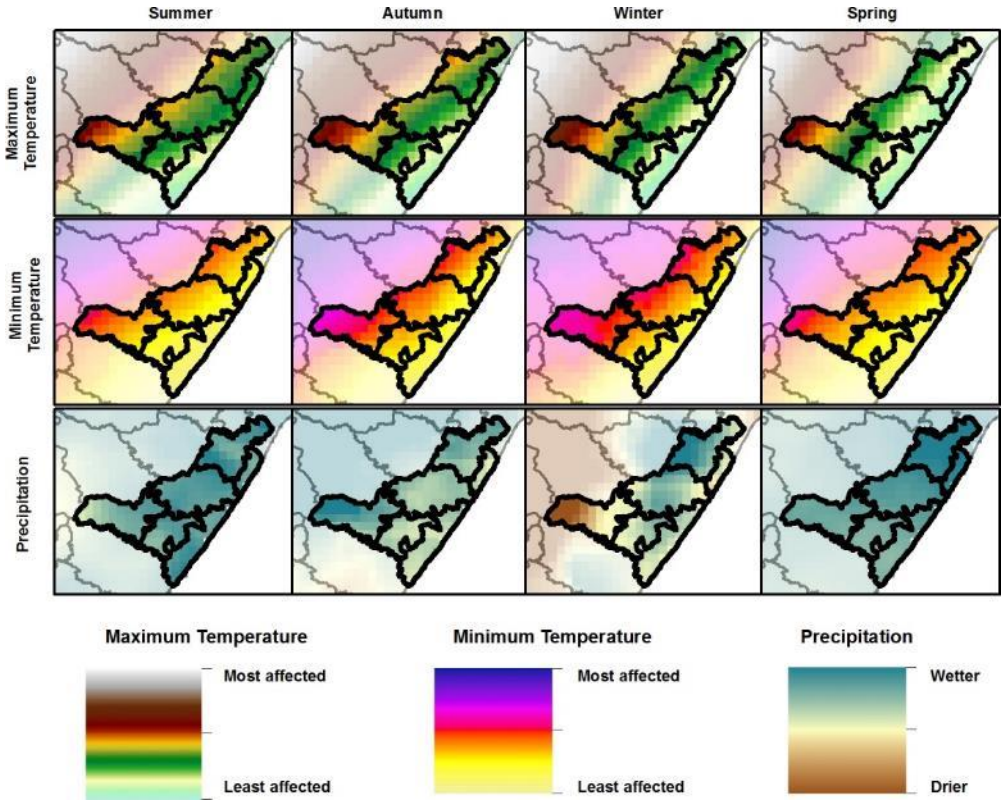


Figure 57: Projected changes per season for the Ugu DM for max temperature, Minimum temperature and annual rainfall.

Recent Climate case study

The drought experienced in Southern Africa and KZN in particular from 2014 to 2015 has had deviating effects on water and food security and has stunted growth and development in the region. Assessment at the Mvoti, Umgeni, Umkomazi, and Umzimkulu basin level highlights anomalous (from 1995) areas depicting decreased annual precipitation of up to 300mm. These areas are mostly to the north of Ugu, these are however form the catchment from which the Mkomazi and Mzimkhulu draw. There are therefore significant implications for the dams and water security of Ugu DM.

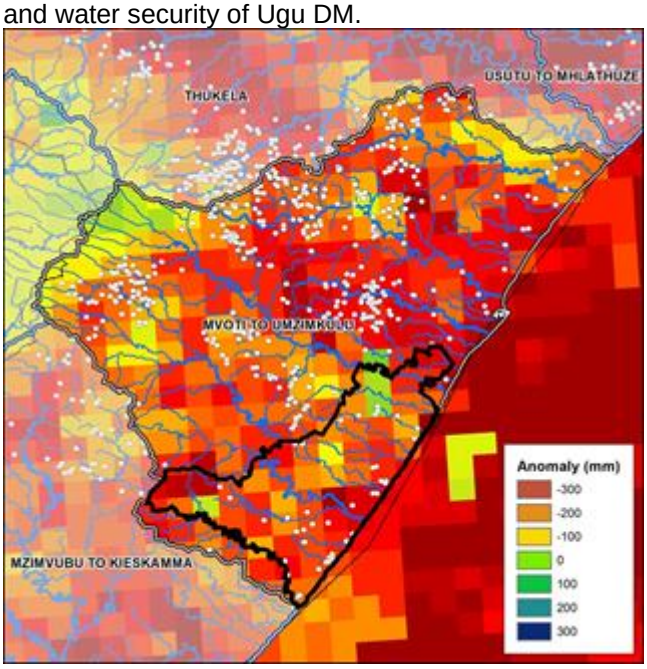


Figure 58: Precipitation anomaly for the 2014/2015 Drought

The implications of this 2014-2016 drought event was particularly sever due to heightened pressure placed on existing water resources through a growth and development that didn't allow for accommodating growth in the water resources sector to buffer against this level of event. However, it should be noted that meteorological events of this nature (in the 10th – 30th percentile of annual rainfall) have occurred previously and will do so again in the future. Droughts of this nature are normal in the atmospheric cycle and El Niño–Southern Oscillation (ENSO) and their occurrence cannot be attributed to climate change. Figure 58 shows the annual precipitation from 1983 to 2016 and the percentile volumes. Drought events can be noted in the time frames of 1990 – 1995, 2002 – 2005, 2008 – 2010 and 2013 to current. These are divided by times of above average precipitation, often aligning with the La Niña period of the ENSO cycle.

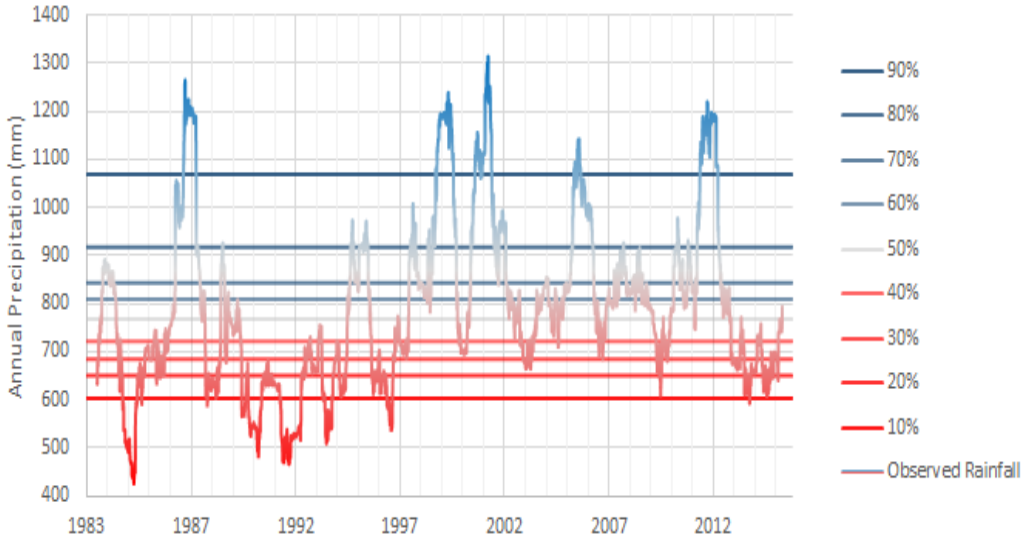


Figure 59: Rainfall changes over time

The climate change analysis shows that while there is a general (slight) increase in total average annual precipitation into the future, there is also a change in the total volume of rainfall in the range of approximately +5% (upper range) to -10% (lower range) of rainfall in a drought year. This means that when a drought event occurs, the total volume of rainfall will likely be decreased in this range (+5% to -10% from normal drought volume). At the more extreme limits these events can be as much as -20% (possible) or -40% (unlikely, but still possible) from the normal drought levels.

Anomalous rainfall years of more or less total annual rainfall as well as the possible extreme severity range of the drought years will need to be accounted for in future development objectives. Adapting to provide enhanced resilience in the water sector through demand management practices or tariffs from the population perspective and through increasing existing or adding further capacity and rolling out maintenance programs.

4 Climate Risk Profile

The results of the climate analysis given above indicate that a change in the climatic conditions of the Ugu District is inevitable, with the district likely to experience higher temperatures, altered rainfall patterns and an increased frequency of drought events. Currently decision-making processes, policy and infrastructure development are largely based on historical climate data. However, the evidence is clear and we can no longer assume climatic patterns to remain constant.

The Ugu District is already familiar with climate related extremes in the form of droughts and flooding, posing a significant risk to the region's economy, ecosystems and population. However the impacts of a changing climate will stretch beyond the impacts of extreme events. Considering the socio-economic and environmental challenges currently faced by the Ugu District, increasing costs associated with the projected climate change impacts will compromise growth and development goals.

Climate related extreme events and long term impacts has already and will continue to place a significant financial burden on public sector service delivery, compounded by prevailing socio-economic and environmental factors contributing to overall vulnerability. This burden will continue to increase, if climate change is not adequately addressed across district through effective response strategies.

A summary of the likely climate change impacts associated with a range of possible climate risks for the Ugu District are summarized in Table 8. These impacts were assed based on the results of the climate assessment, manageability, exposure, and hazard analysis undertaken as well as in consultation with a number of key stakeholders and observations of the current socio-economic conditions.

Table 8: Summary of likely climate change risks and impacts for the Ugu District Municipality

Climate Risk	Likely Climate Change Impacts
Higher mean annual temperatures	• Increased evaporation and decreased water balance; • Reduced crop quality and food security.
Higher maximum temperatures, more hot days and more heat waves	• Increased heat stress on humans and livestock; • Increased incidence of heat-related illnesses; • Increased mortality and serious illness, particularly in older age groups; • Increased heat stress in livestock and wildlife; • Decreased crop yields and rangeland productivity; • Extended range and activity of some pests and disease vectors, specifically malaria; • Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. road surfaces, electrical equipment, etc.);

Climate Risk	Likely Climate Change Impacts
	• Increased electric cooling demand increasing pressure on already stretched energy supply reliability; and • Exacerbation of urban heat island effect.
Higher minimum temperatures, fewer cold days and frost days	• Decreased risk of damage to some crops and increased risk to others such as deciduous fruits that rely on cooling periods; • Reduced heating energy demand; • Extended range and activity of some pests and disease vectors; and
Increased rainfall variability and subsequent drought potential	• Decreased average runoff, stream flow, groundwater recharge; • Decreased water security and potential increases in cost of water resources; • Decreased water quality; • Decrease in shoulder season length threatening sensitive crops; • Increased fire danger (drying factor); and • Impacts on rivers and wetland ecosystems.
Intensification of rainfall events	• Increased flooding; • Increased challenge to storm water systems in settlements; • Increased soil erosion; • Increased river bank erosion and demands for protective structures; • Increased pressure on disaster management systems and response; • Increased risk to human lives and health; and • Negative impact on agriculture such as lower productivity levels and loss of harvest which could lead to food insecurity.
Increased mean sea level and associated storm surges	• Salt water intrusion into groundwater and coastal wetlands; • Increased storm surges leading to coastal flooding, coastal erosion and damage to coastal infrastructure; and • Increased impact on estuaries and associated impacts on fish and other marine species.
The consequences of the projected climate change impacts will not be limited to their physical impacts. Climate change patterns and projected impacts will also have a significant impact on government's ability to perform their mandated roles and responsibilities. The interactions between climate change and government functions will be complex and more comprehensive risk assessments may be required to further assist decision making processes and prioritizing adaptation activities.	

By identifying climate change risks the Ugu District will be better able to prioritize and manage risk by applying relevant mitigation and adaptation strategies. The purpose of this Chapter is to provide an overview of the risks climate change poses to the district and its people to inform decision making and planning processes.

In assessing the Ugu District's climate change exposure profile the report drew on a combination of approaches, considering the impact oriented risk-hazard approach while also drawing additional approaches addressing the social, cultural, and economic factors expressed in chapter 2 in order to assess the impact potential for each of the primary climate change hazards identified. Risk assessment seeks to analyse multiple spatial and temporal source datasets with the intention of better conveying the interactions between and impact on communities, infrastructure and assets from potential risk/hazard events

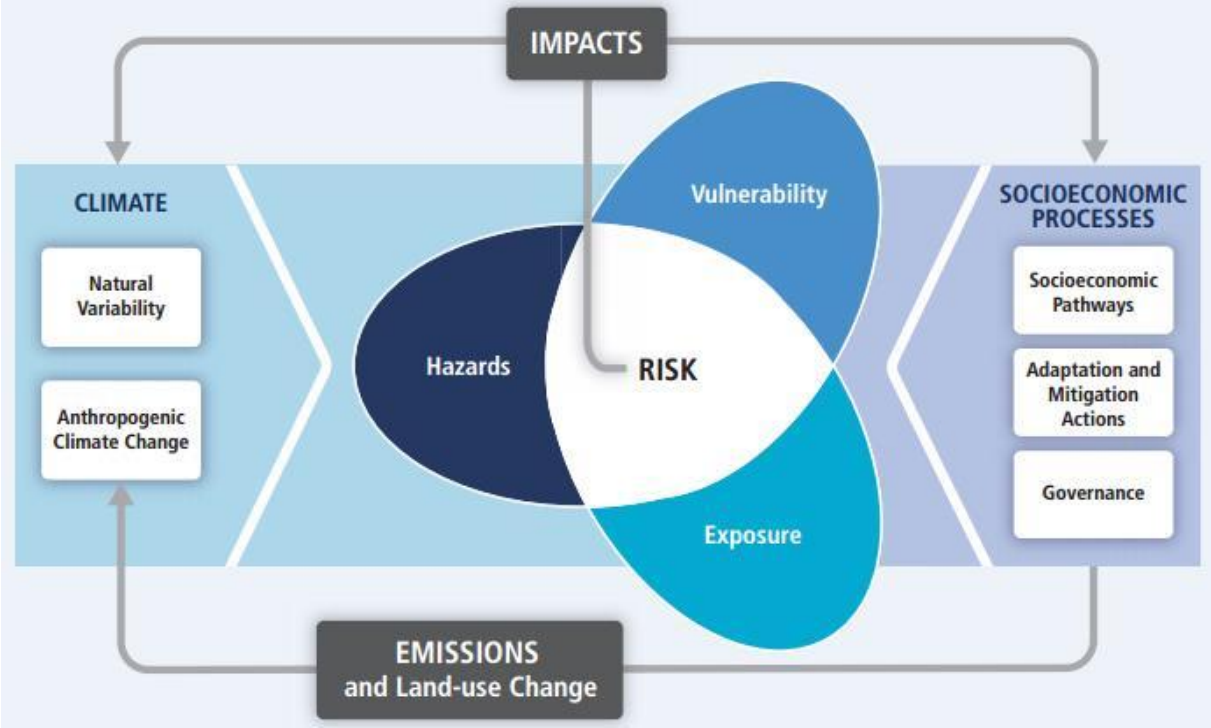


Figure 60: Linking Climate change to risk through development management and adaptation

4.1 Climate Risk measure

Climate change risks at a sub municipal level are measured from the likelihood of the climate change, the forecastability/predictability and the severity of the changed hazard. Furthermore, the exposure to populations, agricultural and plantation areas, environmental resilience; the manageability in the form of measureable adaptation, policy capacity, and personal and institutional capacity are considered. The measures of statistical hazard index, measureable adaptation and policy capacity or done on a local municipal level, while the remainder are utilised at the mesozone scale[81] for analysis.

The risks are classified from least to most important as Insignificant, Minimal, Moderate, Major and Catastrophic Risks. They integrate the workshop risk profiles as well as the situational analysis measured through the CSIR, stepSA and Census data. The status of each variable will meet one of the following scenario types:

	Scenario	Risk profile	Priority response
	Severely negative	Catastrophic Risk	Immediate priority, adaptation urgently needed
	Negative	Major risk	High priority, adaptation needed before conditions deteriorate further
	Medium	Moderate risk	Medium priority, adaptation should follow higher priority actions
	Positive	Minimal Risk	Medium to low priority, should be closely monitored, may become significant
	Very positive	Insignificant Risk	Low priority, no immediate action needed but should be monitored

These relative climate risk priorities are used to highlight each municipality's exposure to each of the main projected climate changes. This is done in Figure 61, and is broken down into urban, rural, subsistence and commercial agriculture areas for each municipality in sections 4.14.1.1 to 4.1.6. Further expansion of the impacts associated with the climate change risks is presented in following sections of the report. This analysis will inform the response recommendations in chapter 5.

[81] CSIR mesoframe– a demarcated grid of 25000 mesozones ~50km² each (www.gap.csir.co.za/techical-overview)

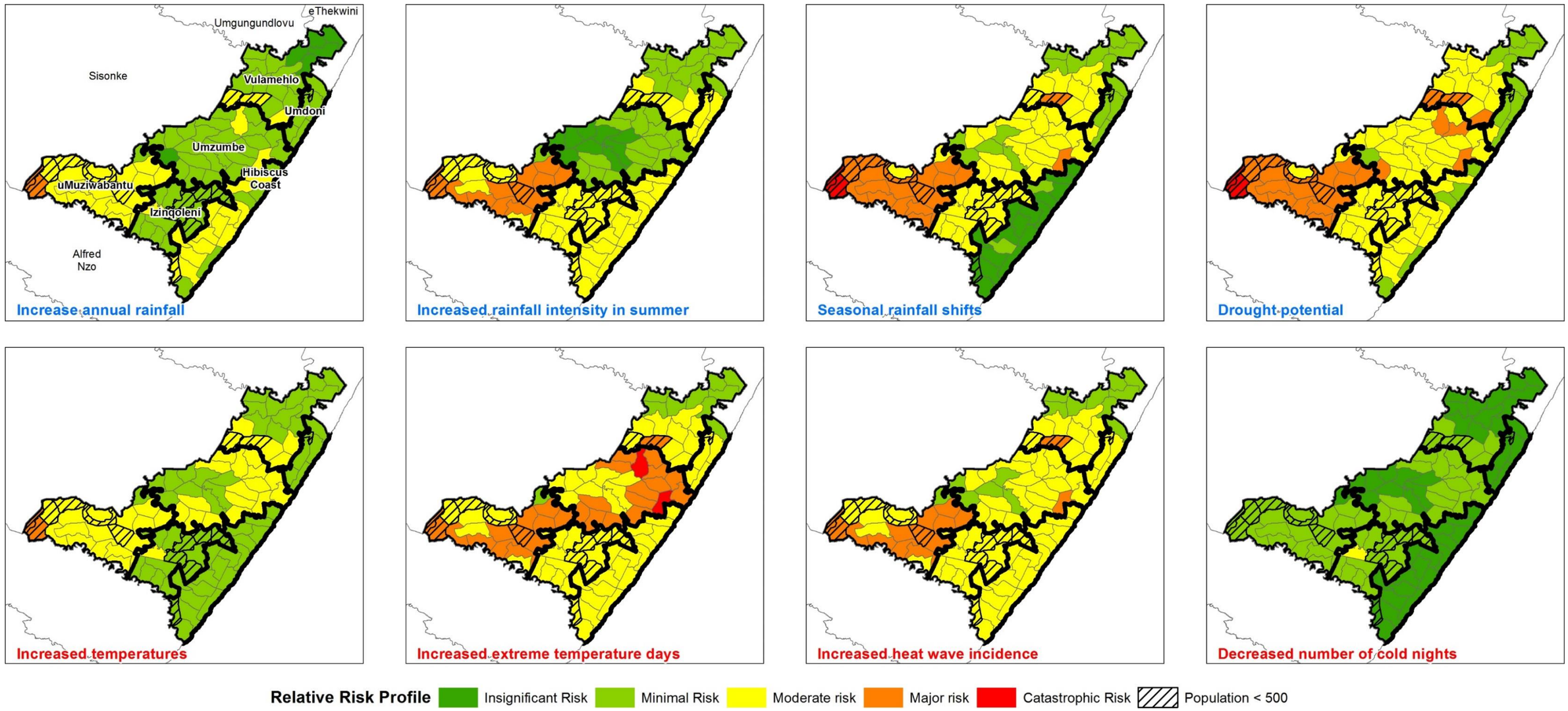


Figure 61: Relative climate risk rating per identified Climate Change Hazard

4.1.1 Hibiscus Coast Local Municipality

Hibiscus Coast LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	**Range of time variability**	**Rural Areas**	**Urban Areas**	**Likelihood**	**Predictability**	**Hazard severity**	**Population clusters**	**Agricultural vulnerability**	**Environmental resilience**	**Cumulative Climatic hazards**
		Commercial farming	**Substance Farming**							
Increase annual rainfall	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Almost certain	Forecastable	Significant impact	There are large population clusters in this LM with high population density. Climate impacts are therefore likely to disrupt more people.	There is commercial agriculture in this LM but is not very sensitive irrigation deficit	This LM is transformed and has commercial agriculture and there is little natural vegetation. Environmental resilience is medium to low	Little climate changes projected to take place in this as the change is mitigated by the proximity to the ocean.
Increased rainfall intensity in summer	> 10 years	Major risk Major risk	Major risk Major risk	Almost certain	Highly variable	Significant impact				
Seasonal rainfall shifts	> 10 years	Minimal Risk Minimal Risk	Insignificant Risk Minimal Risk	Likely	Highly variable	Minimal Impact				
Drought potential	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
							Measureable adaptation	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Minimal Risk Minimal Risk	Minimal Risk Minimal Risk	Almost certain	Forecastable	Medium impact	Social structures allow for better adaptations for the rural and subsistence areas such as usage of water storage and organic farming awareness and mitigation activities. There are maps available for both rural and urban areas to help with planning activities.	The LM focuses on climate change in the IDP and the SDF and sees the need to have this mind-set in development.	The population of this LM have a combined high capacity. This is derived from their level of education and personal income	The institutional capacity is high as there are several economic hubs, urban infrastructure and a focus on development
Increased extreme temperature days	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Almost certain	Mildly predictable	Significant impact				
Increased heat wave incidence	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Almost certain	Mildly predictable	Significant impact				
Decreased number of cold nights	> 10 years	Insignificant Risk Insignificant Risk	Insignificant Risk Insignificant Risk	Almost certain	Forecastable	Minimal Impact				

4.1.2 Umzumbe Local Municipality

Umzumbe LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	**Range of time variability**	**Rural Areas**	**Urban Areas**	**Likelihood**	**Predictability**	**Hazard severity**	**Population clusters**	**Agricultural vulnerability**	**Environmental resilience**	**Cumulative Climatic hazards**
		Commercial farming	**Substance Farming**							
Increase annual rainfall	> 10 years	Minimal Risk Minimal Risk	Minimal Risk Minimal Risk	Likely	Forecastable	Medium impact	This LM has the lowest average population density. Climate change impact will likely affect a smaller number of people.	There is some commercial agriculture. The vulnerability is medium. The most vulnerable would be the subsistence farmers.	While there are areas that have been transformed, the majority of the area is either grassland or larger vegetation. The environmental resilience it good.	Combined climate changes are considered Medium to high, particularly further north.
Increased rainfall intensity in summer	> 10 years	Minimal Risk Minimal Risk	Minimal Risk Minimal Risk	Possible	Highly variable	Minimal Impact				
Seasonal rainfall shifts	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Likely	Highly variable	Medium impact				
Drought potential	> 10 years	Major risk Major risk	Moderate risk Major risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
							Measureable adaptation	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Almost certain	Forecastable	Medium impact	There is very low adaptation rates. There is no (or very slow) delivery of training or support for local rural areas and subsistence farmers. They lack knowledge regarding sustainability and have no adaptation strategy.	The LM focuses briefly on climate change in the IDP. No substantial integrated planning or enforcement.	The population of this LM have a combined low capacity. This is derived from their level of education and personal income.	The institutional capacity is low - medium, there are a few small economic hubs focused in the more populated areas but also significant undeveloped areas.
Increased extreme temperature days	> 10 years	Catastrophic Risk Major risk	Major risk Catastrophic Risk	Almost certain	Mildly predictable	Significant impact				
Increased heat wave incidence	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Almost certain	Mildly predictable	Medium impact				
Decreased number of cold nights	> 10 years	Minimal Risk Minimal Risk	Minimal Risk Minimal Risk	Almost certain	Forecastable	Minimal Impact				

4.1.3 uMuziwabantu Local Municipality

uMuziwabantu LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	**Range of time variability**	**Rural Areas**	**Urban Areas**	**Likelihood**	**Predictability**	**Hazard severity**	**Population clusters**	**Agricultural vulnerability**	**Environmental resilience**	**Cumulative Climatic hazards**
		Commercial farming	**Substance Farming**							
Increase annual rainfall	> 10 years	Moderate risk	Moderate risk	Almost certain	Forecastable	Medium impact	There are a few dispersed population clusters averaging to a medium population density Impacts are likely to disrupt fewer people.	There are large areas dependant on commercial and subsistence agriculture. There is medium to high irrigation deficit focused inland	This LM is transformed and has commercial plantations and there is little natural vegetation. Environmental resilience is low.	Medium climate changes are projected to occur, primarily in the northern areas.
		Moderate risk	Moderate risk							
Increased rainfall intensity in summer	> 10 years	Major risk	Moderate risk	Likely	Highly variable	Medium impact				
		Major risk	Major risk							
Seasonal rainfall shifts	> 10 years	Major risk	Major risk	Almost certain	Highly variable	Medium impact				
		Major risk	Major risk							
Drought potential	> 10 years	Major risk	Major risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
		Major risk	Major risk				**Measureable adaptation**	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Moderate risk	Moderate risk	Almost certain	Forecastable	Medium impact	There is little to no knowledge of adapting to climate hazards and capacities are low. Some areas are undertaking water harvesting and sharing seeds but with is very limited.	The LM focuses briefly on climate change in the IDP. No substantial integrated planning or enforcement.	The population of this LM have a combined medium to low capacity. This is derived from their level of education and personal income.	The institutional capacity is low - medium, there are a few small economic hubs focused in the more populated areas but also significant undeveloped areas
		Moderate risk	Moderate risk							
Increased extreme temperature days	> 10 years	Major risk	Moderate risk	Almost certain	Mildly predictable	Medium impact				
		Major risk	Major risk							
Increased heat wave incidence	> 10 years	Major risk	Moderate risk	Almost certain	Mildly predictable	Medium impact				
		Major risk	Major risk							
Decreased number of cold nights	> 10 years	Minimal Risk	Minimal Risk	Almost certain	Forecastable	Minimal Impact				
		Minimal Risk	Minimal Risk							

4.1.4 Vulamehlo Local Municipality

Vulamehlo LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	**Range of time variability**	**Rural Areas**	**Urban Areas**	**Likelihood**	**Predictability**	**Hazard severity**	**Population clusters**	**Agricultural vulnerability**	**Environmental resilience**	**Cumulative Climatic hazards**
		Commercial farming	**Substance Farming**							
Increase annual rainfall	> 10 years	Moderate risk Minimal Risk	Minimal Risk Moderate risk	Likely	Forecastable	Medium impact	This LM has the medium to low population density focused in the urban areas. Climate impacts impact will likely affect a large number of people in a smaller area.	There are large areas of commercial agriculture and there is sensitivity to rainfall variability. Vulnerability is medium to high.	This LM has large areas under commercial crops but also large grassland/vegetation areas. This LM has a medium resilience	Combined climate changes are considered high in this LM compared to the remaining district
Increased rainfall intensity in summer	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Possible	Highly variable	Medium impact				
Seasonal rainfall shifts	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Likely	Highly variable	Medium impact				
Drought potential	> 10 years	Major risk Major risk	Major risk Major risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
							Measureable adaptation	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Almost certain	Forecastable	Medium impact	There is very low adaptation rates and little implementation of technology. There is no (or very slow) delivery of training or support for locals and they lack knowledge regarding sustainability and have no adaptation strategy.	The LM focuses on climate change and sees it as a challenge to sustainable growth. This is a good start, but needs follow-through	The population of this LM have a combined low capacity. This is derived from their level of education and personal income.	The institutional capacity is medium. This LM has a mix of urbanised and rural areas. More formalised areas to the north east.
Increased extreme temperature days	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Almost certain	Mildly predictable	Medium impact				
Increased heat wave incidence	> 10 years	Major risk Moderate risk	Moderate risk Major risk	Almost certain	Mildly predictable	Medium impact				
Decreased number of cold nights	> 10 years	Minimal Risk Minimal Risk	Minimal Risk Minimal Risk	Almost certain	Forecastable	Minimal Impact				

4.1.5 uMdoni Local Municipality

uMdoni LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	**Range of time variability**	**Rural Areas**	**Urban Areas**	**Likelihood**	**Predictability**	**Hazard severity**	**Population clusters**	**Agricultural vulnerability**	**Environmental resilience**	**Cumulative Climatic hazards**
		Commercial farming	**Substance Farming**							
Increase annual rainfall	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Likely	Forecastable	Significant impact	This LM has a high population density clustered to the west. Impacts in this area will have a larger disruption.	There is significant commercial agriculture in this LM and has a medium sensitivity to rainfall variations	This LM is transformed and has significant commercial agriculture and there is little natural vegetation. Environmental resilience is low	Climate will change in this LM but the impacts are less than other areas.
Increased rainfall intensity in summer	> 10 years	Major risk Major risk	Major risk Major risk	Likely	Highly variable	Significant impact				
Seasonal rainfall shifts	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Likely	Highly variable	Medium impact				
Drought potential	> 10 years	Moderate risk Moderate risk	Moderate risk Moderate risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
							Measureable adaptation	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Moderate risk Minimal Risk	Minimal Risk Moderate risk	Almost certain	Forecastable	Medium impact	Strong adaptation and technology in the commercial areas and better landuse management has increased the adaptive capacity of the area.	The LM focuses on climate change in the IDP and the SDF and sees the need to have this mind-set in development	The population of this LM have a combined high capacity. This is derived from their level of education and personal income	The institutional capacity is high as there are several economic hubs, urban infrastructure and a focus on development
Increased extreme temperature days	> 10 years	Major risk Major risk	Major risk Major risk	Almost certain	Mildly predictable	Significant impact				
Increased heat wave incidence	> 10 years	Major risk Major risk	Major risk Major risk	Almost certain	Mildly predictable	Significant impact				
Decreased number of cold nights	> 10 years	Minimal Risk Insignificant Risk	Insignificant Risk Insignificant Risk	Almost certain	Forecastable	Minimal Impact				

4.1.6 Izinqoleni Local Municipality

Izinqoleni LM		Relative Risk Priority		Hazard Indices			Vulnerability Rating			
Climate change impacts	Range of time variability	Rural Areas	Urban Areas	Likelihood	Predictability	Hazard severity	Population clusters	Agricultural vulnerability	Environmental resilience	Cumulative Climatic hazards
		Commercial farming	Substance Farming							
Increase annual rainfall	> 10 years	Moderate risk	Moderate risk	Almost certain	Forecastable	Medium impact	There is one main population centre. The remaining areas have medium to low density population. Higher density results in impact to a greater number of people.	There are areas of large scale agriculture. Reliance on potential irregularity of rainfall may increase vulnerability.	There are transformed areas and also large areas of commercial agriculture, this is however balanced by area under grassland or other vegetation and the area has medium environmental resilience	While there will be climate changes in the LM, these are significantly less than in other areas of the DM.
		Moderate risk	Moderate risk							
Increased rainfall intensity in summer	> 10 years	Major risk	Moderate risk	Likely	Highly variable	Medium impact				
		Moderate risk	Major risk							
Seasonal rainfall shifts	> 10 years	Major risk	Major risk	Almost certain	Highly variable	Medium impact				
		Major risk	Major risk							
Drought potential	> 10 years	Major risk	Major risk	Likely	Mildly predictable	Significant impact	**Manageability / Capacity to Cope indices**			
		Major risk	Major risk				**Measureable adaptation**	**Policy capacity**	**Personal Capacity**	**Institutional Capacity**
Increased temperatures	> 10 years	Moderate risk	Moderate risk	Almost certain	Forecastable	Medium impact	There is some assistance from the communities and institutions with training however this is happening slowly. There is poor adherence to and knowledge of legislation. Communities adopting water harvesting techniques to increase reliance.	The IDP stresses responses to climate change as a PGDS Strategic Goal. Beyond that there is little policy specifying climate change actions.	The population of this LM have a combined low capacity. This is derived from their level of education and personal income	The institutional capacity is low as there as areas are predominantly classified as rural and lacking infrastructure.
		Moderate risk	Moderate risk							
Increased extreme temperature days	> 10 years	Major risk	Moderate risk	Almost certain	Mildly predictable	Medium impact				
		Moderate risk	Major risk							
Increased heat wave incidence	> 10 years	Major risk	Moderate risk	Almost certain	Mildly predictable	Medium impact				
		Moderate risk	Major risk							
Decreased number of cold nights	> 10 years	Moderate risk	Moderate risk	Almost certain	Forecastable	Medium impact				
		Moderate risk	Moderate risk							

4.2 Local Stakeholder Climate Risk engagement

The local level workshop engagements have reviled the perception of local stakeholders of the climate risk as well as the priority sectors for the area. The quantitative assessment highlighted and reinforced that rural areas and subsistence agriculture had higher exposure to risk, having lowered resilience than the urban and commercial agriculture areas. This disparity is expressed further through the capacity assessment showing lowered personal and institutional capacity in these areas as well as policy compliance and measured adaptations on the ground (Table 9).

Table 9: Exposure and Capacity of different area types

		Rural	Urban	Commercial Agriculture	Substance Agriculture
Exposure	Population	High	Medium	n/a	n/a
	Agriculture	n/a	n/a	Medium	Very High
	Environmental	Medium - High	Medium	Medium	Medium
	Impact Climate change potential	Very high	Medium	Medium - High	Very high
Capacity	Personal	Low	Medium	Medium	Low
	Intuitional	Low	Medium	Medium	Low
	Measureable adaptation	Low	Medium	Low – Medium	Low
	policy compliance	Very low	Medium	Low – Medium	Very Low

The priority sectors identified (Table 10) were agriculture, biodiversity community related (infrastructure and disaster management) and tourism sectors. This assessment was motivated through the local ground level knowledge of the stakeholders in terms of the varying hazards and the exposure and capacity for each of the area types. The additional important sectors of water resources and energy were added to the strategic assessment.

Table 10: Priority climate risk and sector impacts – local perspective

Precipitation impacts. Increasing volumes, intensity and variability
• Agriculture
  ○ Both potentially positive and negative impacts on agricultural yields.
  ○ Impacts to agriculture, alter crop suitability and timing.
  ○ Floods impacting commercial and subsistence agriculture.
• Tourism
  ○ Tourism decreased due to negative weather perception (rain, cloud and wind).
  ○ Beach degradation impacting tourism potential.
• Biodiversity
  ○ Both potentially positive and negative impacts to biodiversity. Rainfall regime may favour alien invasive species.
  ○ Environmental degradation though enhanced erosion and sedimentation.
	Drought potential
	• Agriculture
	  ○ Reduced crop yield for both commercial and subsistence farmers.
	  ○ Inability to give water to livestock.
	  ○ Increased food prices.
	  ○ Irrigation demand increases
	• Biodiversity
	  ○ Limited adaptability may favour other species.
	  ○ Decreased water quality.
	  ○ Impacts to aquaculture.
	  ○ Increased completion for water for game vs human usage.
	  ○
	• Communities

○ Biodiversity may be impacted and result in species migration. • Communities ○ Property and infrastructure damage due to increased stress on storm water systems, roads and bridges. ○ Negative impacts to traffic flow. ○ Poorly developed areas may be negatively affected through enhanced flood potential impacting disaster management capacity. ○ Fast runoff may put pressure on dam storage. ○ Reduces productivity of construction and development. ○ Positive contribution to the water table. ○ Enhanced water capture opportunity.	○ Communities reliant on rivers for drinking water. ○ Insufficient drinking water in urban areas ○ Malnutrition and disease increases. ○ Impacts livelihood strategies. ○ Pressure on disaster management resources. ○ Enhanced vulnerability of population. • Tourism ○ Negative impacts on tourism if water supply is compromised.
Temperatures increasing in general and extremes • Agriculture ○ Crop suitability may vary due to temperature change. ○ Increased evaporation and reduced soil moisture. ○ Livestock and crop stress. ○ Irrigation demand increases. ○ Enhanced fire potential. ○ Impacts food security. • Biodiversity ○ Enhanced fire potential. ○ Potential species migration and alien invasive species. ○ More evaporation from rivers and evapotranspiration. • Communities. ○ Pressure on disaster management resources. ○ Increased demand of cooling. Pressure on energy sector. ○ Lower population productivity. ○ Impacts to human health. ○ Increased demand on water resources. ○ Infrastructure damage due to thermal expansion ○ Effects on the Elderly and those with chronic conditions. • Tourism ○ Increased perception of area as holiday destination. ○ Enhanced ecotourism opportunities. ○ Potentially more drowning incidents	*Ocean impacts* • Agriculture ○ Subsistence fishing changes in fish migration/distribution will impact food security ○ Salt intrusion into the water table. • Communities. ○ Affects negatively those business/dwellings that are built close to ocean. ○ Erosion damages to Infrastructure. ○ Inundation of developments. ○ Relocation requires significant investment. • Biodiversity ○ Habitat loss. ○ Inundation of vegetated areas, river mouths and estuaries. ○ Damage to environmental buffer zones • Tourism ○ May open up new areas for beach activity but may also reduce these areas.

4.3 Priority Sectors

Climate change impacts will affect almost all sectors to varying extents (Figure 62). Local government will have to pay attention to time horizons and the evolution of risks associated with projected climate changes, and reassess the suitability of response options and projects over time. Climate change related insecurity in one sector may also be diffused to other sector through complex their complex interrelationships. A balanced approach with short, medium and long term adaptation interventions will be critical for reducing vulnerability to climate change impacts and achieving sustainable growth and development.

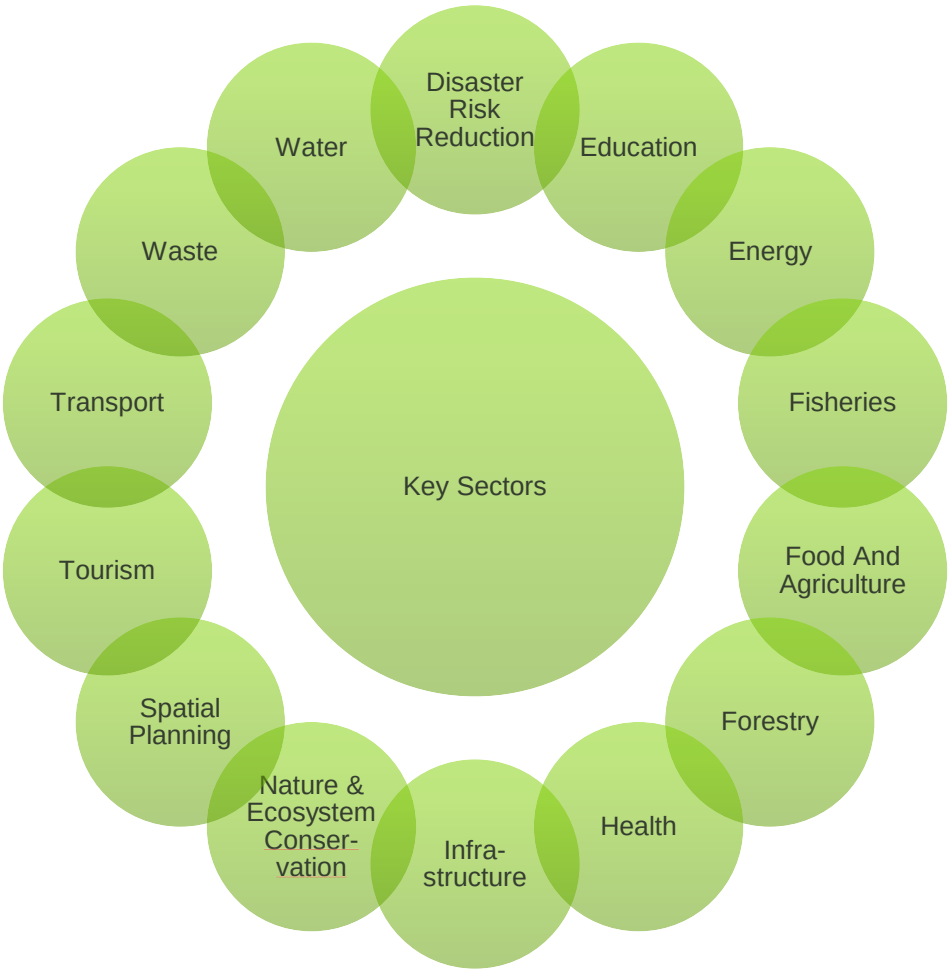


Figure 62 Sectors affected by climate change[82]

In order to implement an effective response to climate change, primary response efforts will be focused on priority sectors to assist with the mainstreaming of climate change response. The priority sectors should be reviewed on a regular basis to assess relevance in the context of future conditions. Priority sectors have been identified based on the climate and potential significance of impacts, sectors' economic importance, significance of adaptation measures in the sector, time horizons of impacts and urgency of intervention, and potential social and environmental significance of climate change impacts. The identified priority sectors and urgency of response are given in Table 11.

Table 11: Prioritization based economic, social and environmental criteria and temporal scales.

Sector	Primary Impact Category	Urgency/Time horizon of impact
Energy	Social	Medium Term 2020-2050
Municipal Infrastructure	Economic	Short term - 2015-2020
Water Resources	Social/Environmental	Short & Medium Term 2015 - 2050
Terrestrial Biodiversity	Environmental	Long Term +2050
Disaster Management	Economic/Social	Medium Term 2020-2050
Agriculture	Economic/Social	Short & Medium Term 2015 - 2050
Tourism	Social/Economic	Short, Medium & Long Term +2050

These sectors are elaborated on in the following sections.

[82] UN CC: Learn. 2014. Introduction to Climate Change Adaptation.

4.3.1 Sectoral risk and impacts vs municipality risk profile.

Tables below summarize each of the climate change impacts that potentially affect the different sectors. It presents the climate risk profiles of each local municipality and area type against the identified likely climate change risk and impacts associated with the changed climate parameter. Discretion is required by the user to determine the ultimate priority applicable to each area type and municipality for the different climate hazards, these tables amalgamate the relationship between climate hazard potential, exposure and adaptive potential on a municipal level for the different area types and do not necessarily reflect the local scale priorities.
Further elaboration on the sectoral risk and impacts are given in section 4.3.2.

4.3.1.1 Energy

Energy	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding potentially damaging electrical infrastructure • Increased average runoff, stream flow, groundwater recharge
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased temperatures negatively impact solar power production • Increased electric cooling demand increasing pressure on already stretched energy supply reliability
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Increased temperatures negatively impact solar power production • Increased electric cooling demand increasing pressure on already stretched energy supply reliability
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	• Increased temperatures negatively impact solar power production • Increased electric cooling demand increasing pressure on already stretched energy supply reliability
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

4.3.1.2 Municipal Infrastructure

Municipal Infrastructure	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding potentially damaging infrastructure • Increased challenge to storm water systems in settlements • Increased soil erosion, long term damage to infrastructure • Increased river bank erosion and demands for protective structures
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. road surfaces, electrical equipment, etc.) • Exacerbation of urban heat island effect
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. road surfaces, electrical equipment, etc.) • Exacerbation of urban heat island effect
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	• Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. road surfaces, electrical equipment, etc.) • Exacerbation of urban heat island effect
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

4.3.1.3 Water Resources

Water Resources	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Increased average runoff, stream flow, groundwater recharge • Increased flooding potential • Increased challenge to storm water systems in settlements • Impacts on rivers and wetland ecosystems
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding • Increased challenge to storm water systems in settlements • Increased soil erosion • Increased river bank erosion and demands for protective structures
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	• Decrease in shoulder season length impacts water resources and increases dry spell duration • Planting regimes impacted through anomalous rainfall patterns
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	• Traditional planting regimes and variety impacted through anomalous rainfall patterns • Less over all water available for all sectors with potential water-shedding / increased water stress • Reduced water security / quality • Impacts on rivers / wetland ecosystems • Overexploitation of groundwater resources
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased evaporation and decreased water balance
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	

4.3.1.4 Terrestrial Biodiversity

Terrestrial Biodiversity	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Increased soil erosion • Increased river bank erosion and demands for protective structures • Impacts on rivers and wetland ecosystems
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	• Decrease in shoulder season length threatening sensitive vegetation • Changes may disrupt growing patterns and may focus particular species over indigenous vegetation
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased evaporation and decreased water balance • Anomalous temperature may bias in favour of particular species over indigenous vegetation
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Decreased number of cold nights	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	• Extended range and activity of some pests and disease vectors • Anomalous temperature may bias in favour of particular species over indigenous vegetation
	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	

4.3.1.5 Disaster Management

Disaster Management	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding. risk to human lives and health • Increased challenge to storm water systems in settlements • Increased river bank erosion and demands for protective structures • Increased pressure on disaster management systems and response
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	• Less over all water available for all sectors • Potential water-shedding and increased water stress • Reduced water security • Decreased water quality • Exploitation and overexploitation of groundwater resources
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Increased heat stress on humans and livestock • Increased incidence of heat-related illnesses • Increased mortality and serious illness, particularly in older age groups
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	• Extended range and activity of some pests and disease vectors, specifically malaria • Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. road surfaces, electrical equipment, etc.) • Increased heat stress in livestock and wildlife
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

4.3.1.6 Agriculture

Agriculture	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Increased average runoff, stream flow, groundwater recharge • Increased flooding and crop damage potential • Increased soil erosion • Increased river bank erosion and demands for protective structures • Traditional planting regimes and variety impacted through anomalous rainfall patterns
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding • Increased soil erosion • Increased river bank erosion and demands for protective structures • Increased risk to human and livestock lives and health • Negative impact on agriculture such as lower productivity levels and loss of harvest which could lead to food insecurity
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	• Decrease in shoulder season length threatening sensitive crops • Traditional planting regimes impacted through anomalous rainfall patterns • Shorter rain periods impact the maturity of crops reducing the quality and yield
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	• Traditional planting regimes and variety impacted through anomalous rainfall patterns • Less over all water available for all sectors • Potential increased water stress • Decreased water quality • Exploitation and overexploitation of groundwater resources
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased evaporation and decreased water balance

Agriculture	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Reduced crop quality and food security
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Increased heat stress on humans and livestock • Increased incidence of heat-related illnesses
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	• Decreased crop yields and rangeland productivity • Extended range and activity of some pests and disease vectors, specifically malaria • Increased heat stress in livestock and wildlife
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Decreased number of cold nights	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	• Extended range and activity of some pests and disease vectors • Reduced risk of cold-related deaths and illnesses
	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	

4.3.1.7 Tourism

Tourism	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Risks and impacts**
	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	Commercial farming	Substance Farming	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Increased rainfall might change the perception as a tourist destination, particularly as most attractions are outdoors • Increased river bank and beach erosion decreases tourism appeal
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Increased flooding and damage to tourism infrastructure • Increased pressure on disaster management systems and response • Increased risk to human lives and health
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	• Less over all water available for all sectors • Changes to weather during holiday period, may become unsuitable
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	• Less over all water available for all sectors, water insecurity will be a disincentive to travel • Decreased water quality
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Increased heat stress on humans in outdoor areas • Increased incidence of heat-related illnesses • Activities may no longer be feasible in extreme temperatures
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	

4.3.2 Expanded Sectoral impacts

The details below provide more information to the risks and vulnerabilities likely to be experienced in each of the major sectors within Ugu District. The risk and vulnerabilities between the various sectors will be different in each local municipality. It should be noted that sea-level rise will affect several sectors and will therefore have sector specific impacts in appropriate sections.

4.3.2.1 Energy Sector

It is clear that the projected impacts of climate change will be increasingly experienced in the years to come, with significant consequences for the electricity sector. Addressing climate change risks and guaranteeing a consistent supply of electricity will require the UGU DM to address the ageing electricity infrastructure and current levels of carbon emissions.

Focus Area	Potential Risks
Energy	• Increased energy demand related to heating and cooling; • Damage to distribution infrastructure due to extreme weather events and veldfires; and • Potential impacts of climate variations on renewable energy production.

With regards to climate change impacts on the energy sector we are able to differentiate between direct and indirect impacts. Direct impacts will affect energy resource availability, power production, transmission and distribution. Indirect impacts include factors such as competition for shared resources and altered supply and demand trends. Direct impacts are generally more visible but the costs of indirect impacts often exceeds direct impacts Even with current national policies favouring energy efficiency and renewable energy, energy demands are expected to continue increasing. Along with the expected demand for energy, price increases are also anticipated. Climate change variables are expected to increase energy demands to varying degrees as heating and/or cooling requirements increase, compounding the existing pressures on electricity supplies in the UGU DM.

Renewable energy will prove fundamental to increasing the resilience of the energy sector, both increasing the electricity systems resilience in the short term and mitigating climate change over the long term. However, the increased intensity of extreme weather events and temperatures has the potential to affect both traditional and renewable energy production and distribution infrastructure. The risks posed to the energy sector will be dependent on vulnerability of related infrastructure and availability of resources. For example, following service disruptions caused by climate change related impacts and extreme events, restoring distribution will be dependent on road access and availability of resources and infrastructure components. The electricity sector does provide opportunities for supply and demand-side interventions including renewable energy and green building design.

- **Renewable energy generation potential**

Using renewable energy sources will assist Ugu DM in mitigating climate change impacts associated with heavy reliance on fossil fuels. The following are cursory analyses and while Ugu district does have an opportunity turn to greener renewable energy production, an in-depth cost/benefit analysis must be undertaken in combination with the climate change analysis as part of a prefeasibility study before any investment is undertaken.

Utilisation of alternate energy sources may help offset the carbon emission through fossil fuel firing generation. Ultimately the use of technology will come to the long term cost benefit of each solution. Recent advancements made renewable energy production, public resistance to fossil fuel reliance, changes in fossil fuel grade and increased pressures placed on limited fossil fuel reserves have made renewable energy generation a more competitive alternative to traditional fossil fuel generation technologies. Discounts and subsidies for utilising renewable energy sources have further increased the incentive of using the technology. The levelised costs of electricity (LCOE) accounts for all costs over a generation facilities lifetime, from initial investment, operations and maintenance and fuel cost.

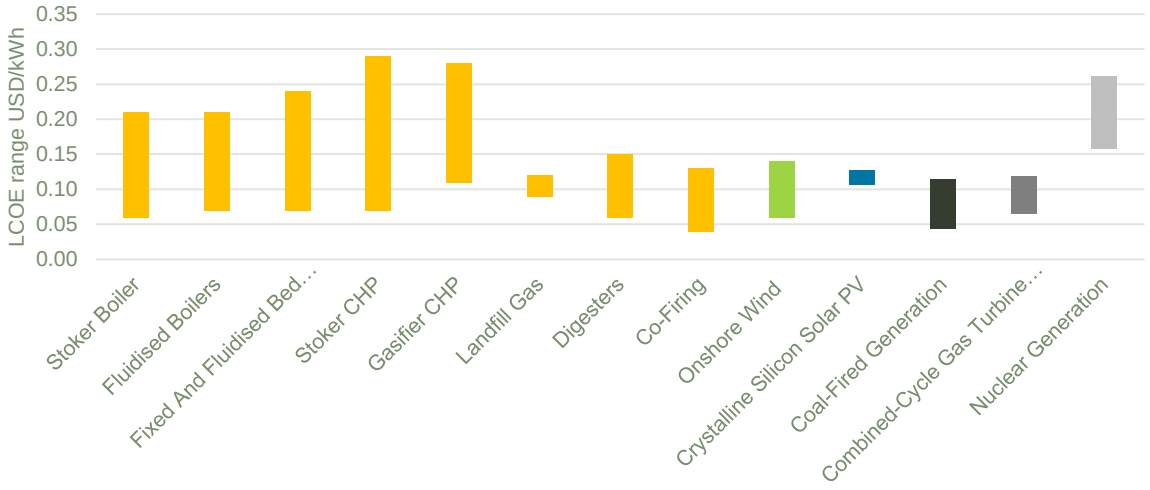
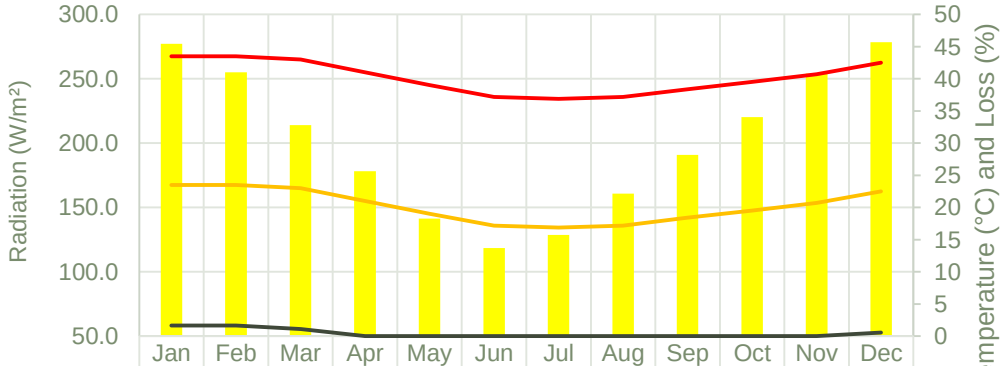


Figure 63: LCOE and various energy generation technologies[83]

There is a decrease in the costs of renewable energy technologies yet the immaturity of the methodologies results in a wide variance of costs between countries and local scale factors. Precise site specific variables will need to be assessed to order to measure competitiveness to fossil fuel reliance. These factors include initial investment expense, operation and maintenance, fuel expense and availability, potential energy production, discount/subsidies and viable lifetime of the facility.

Solar energy

Ugu District receives the majority of its daily solar radiation during the summer months (Figure 64). At times of peak generation solar facilities can augment any additional electricity capacity back into the national grid. At this time there are also higher ambient temperatures and there will likely be a decrease in generation efficiency at these times. During winter months less radiation is available and generation capacity is reduced. At such times additional capacity may be needed from the national grid to meet consumer demand.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar radiation (W/m²)	277.1	255.1	214.0	178.2	141.4	118.6	128.7	160.9	191.0	220.3	254.1	278.5
Ambient Temperature (°C)	23.5	23.5	23.0	21.0	19.0	17.2	16.9	17.2	18.4	19.5	20.7	22.5
Solar temperature (°C)	43.5	43.5	43.0	41.0	39.0	37.2	36.9	37.2	38.4	39.5	40.7	42.5
Efficiency loss (%)	1.7	1.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6

[83] The International Renewable Energy agency, IRENA, Renewable Energy Technologies: cost analysis series

Figure 64: Monthly Solar radiation climatology (W/m²)[84]

It should be noted though that temperature of photo voltaic cells will impact the efficiency of energy production[85]. Solar panels operate on average 20°C warmer than the ambient temperature. Studies have shown that generating efficiency decreases by 1.1% for each 1°C above an operating temperature of 42°C[86]. Therefore with an ambient temperature of 20°C, the solar panels are operating at approximately 40°C with 0% efficiency loss. However in Port Shepstone the summer time temperatures reach an average of 23-24°C which results in an operating temperature of approximately 43-44°C and an average efficiency loss of 1.1 – 2.2%. During heat waves and extreme temperatures, this loss is even greater. Efficiency of generation is increased during cooler temperatures[87]. The near cloudless winters of Ugu will receive the benefit from the decreased temperatures, though will receive less solar radiation. Ugu district does have an opportunity turn to greener renewable energy production but an in-depth cost/benefit analysis must be undertaken in combination with the climate change analysis as part of a prefeasibility study before any significant investment is undertaken.

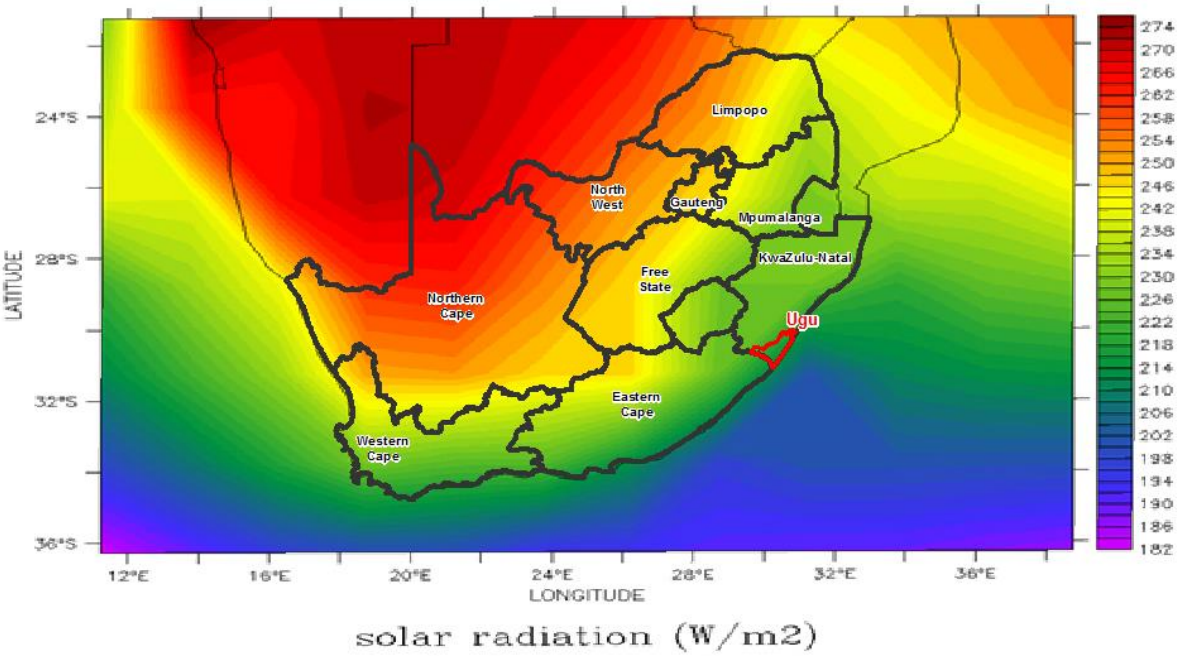


Figure 65: South African solar radiation Climatology (W/m²). Red areas have higher average annual radiation.

Wind energy

This assessment uses macroscale wind climatology[88] assessing the overarching wind resource potential. The cursory assessment shows that east coast has significantly less potential for wind power generation than is noted along the west coast. Wind power is directly proportional to the cube of the local scale wind speed - $P = \frac{1}{2}\rho U^3$ [W/m^2] (watt per square meter), ρ = wind density. Therefore lower wind speeds produce exponentially less wind power.

[84] International Satellite Cloud Climatology Project (ISCCP), historical monthly cloudiness and solar radiation http://isccp.giss.nasa.gov/projects/flux.html

[85] Omubo-Pepple, V.B., Israel-Cookey, C., Alaminokuma, G.I. Effects of Temperature, Solar Flux, and Relative Humidity on the Efficient Conversion of Solar Energy to Electricity (2014) European Journal of Scientific Research:

[86] Renewable Energy UK: Effect of Temperature on Solar Panels

[87] Butay, D.F., Miller, M.T. (2008), Maximum Peak Power Tracker: A Solar Application, Worcester Polytechnic Institute

[88] Earth System Research Laboratory (ESRL),

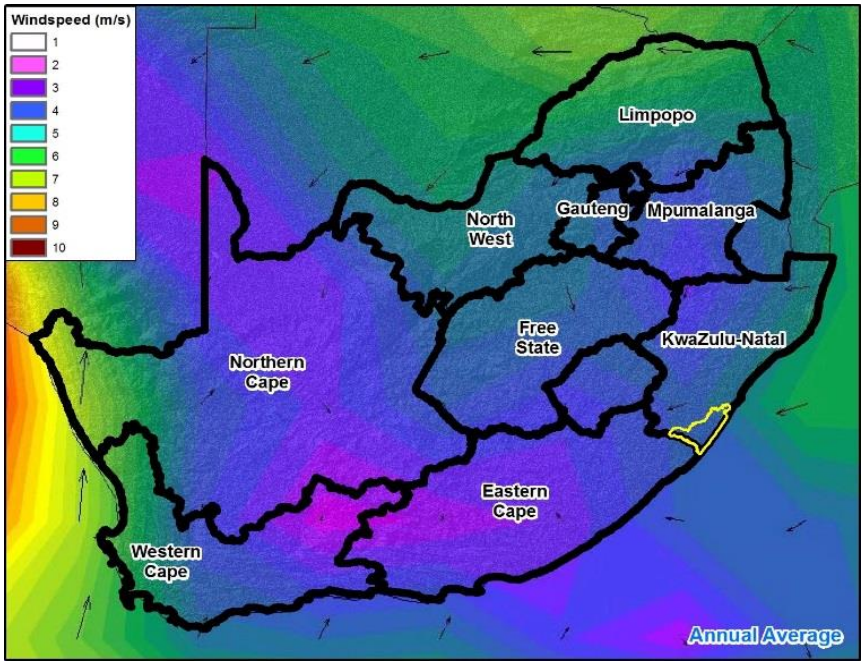


Figure 66: Macroscale wind speed assessment

The International Renewable Energy Agency presents energy production potential at a level local to Ugu DM. There is a bias in wind energy potential along coastal areas, ridges and exposed areas that could be potentially utilised for locations of wind farms. There is the highest energy potential available along the coastal areas and diminishing further inland. This is as a result of the surface roughness increasing in the higher relief areas. There are locations inland that exhibit high potential power generation as they are elevated and exposed with decreased roughness.

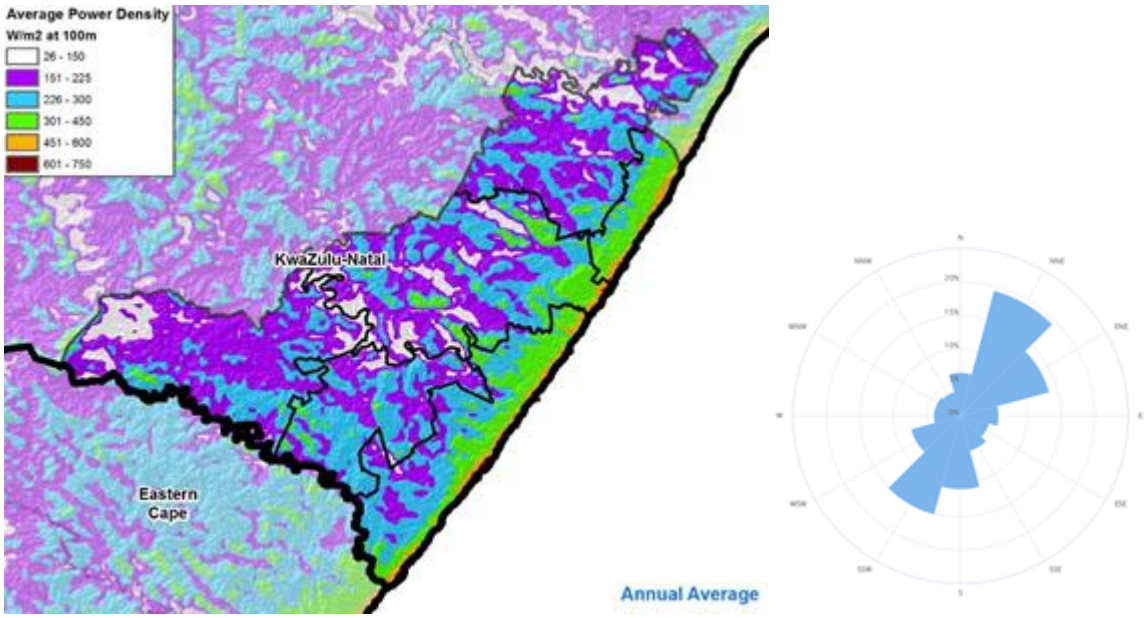


Figure 67: Global Wind Atlas high resolution power density and wind rose wind climatology[89]

[89] The International Renewable Energy agency, Global Wind Atlas

This data is created from Wind Atlas Analysis and Application Program (WAsP) modelled at the microscale in order to capture small scale wind speed variability as influenced by terrain elevation, and surface roughness. Any potential wind farm development would need to be cognisant of the dominating north easterlies and south westerlies and design the facility accordingly. Further higher resolution analysis is currently being developed as part of the WASA project. Phase 1 has been completed, but covers only Western Cape and Eastern Cape. Phase 2 is scheduled to be completed in 2018, the progress of which can be followed here http://www.wasaproject.info/. The outputs of these data should be considered in the initial stages of a prefeasibility study of possible locations for wind turbines.

Biomass energy

Ugu has extensive biological resources and therefore has the potential to utilise these in the production of biofuels. The commercial agriculture industry in Ugu DM provides significant input to the country and has the opportunity to use the waste from sugarcane and timber processing to support biofuel initiatives. Ugu DM Have the potential to enter into the production of bioethanol due to the extensive area under sugarcane and tropical sugar beet in particular has been identified as a potential feedstock for the production of bioethanol. The usage of sugarcane to create bioethanol is however significantly more expensive (25%) than sorghum (the other primary bioethanol option) due to the supply and demand, markets, cost and pricing of outputs[90]. Maize crop could also be used in the production of bioethanol but it is currently banned from this use as it is the country's staple food. Furthermore Soybeans have been identified as a field crop produced with sufficient quantity in KZN that can act as a viable fuel for the production of biodiesel[91]. Other potential crop for biofuel exploitation would be canola, cassava, jatropha, and sunflowers.

The estimated GHG saving if the utilisation of bioethanol and biodiesel produced from these sources used would be in the order of 30% and 50% respectively.

4.3.2.2 Municipal Infrastructure

Focus Area	Potential Risks
Infrastructure Projects including transport, buildings, water management, waste water treatment and waste management	• Changes in rates of deterioration due to changes in precipitation and temperature; • Inundation of roads resulting in deterioration or destruction; • Interruption of road traffic and disruption of emergency transport routes due to extreme climatic events; • Disruption of emergency routes; • Increased intensity of precipitation may cause intrusion into waste water networks; • Capacity of existing flood defences and drainage systems may be exceeded; • Reduction of drainage capacity due to sea level rise or storm surges; • Changes in mean and peak flow rates or rivers; • Reduced precipitation may impact on functioning of storm water systems; • Altered heating and cooling cost; • Increased risk of damage from fires or extreme hydro-meteorological events; • Higher rates of deterioration and increased maintenance costs; • Increased erosion and periods inundation; • Increased or permanent inundation of infrastructure and utilities; • Loss of public property due to inundation; • Impacts on tourism due to changes in biodiversity, water availability;

[90] Biofuels pricing and Manufacturing economics, Department of Energy, www.energy.gov.za

[91] An Economic Evaluation of Soybean-Based Biodiesel Production on Commercial Farms in the Soybean-Producing Regions of KwaZulu-Natal: Some Preliminary Results, Sparks, GD; Ortmann, GF; and Lagrange, L

	• Increased operating cost and maintenance of public property due to extreme weather events; • Reduced water quality and quantity for irrigation; and • Potential for beach closures due to extreme weather and/or pollution levels

At present little specific research has been done to assess the impact of climate change on infrastructure at the municipal level. Changing climate variables has the potential to significantly impact municipal infrastructure, and local governments will be required to consider climate change implications when planning future infrastructure projects. A detailed analysis of municipal asset registers highlighting maintenance and condition of all assets will provide an indication of asset specific risk. An overview of the district and local municipal infrastructure at risk of climate change are presented in the table below.

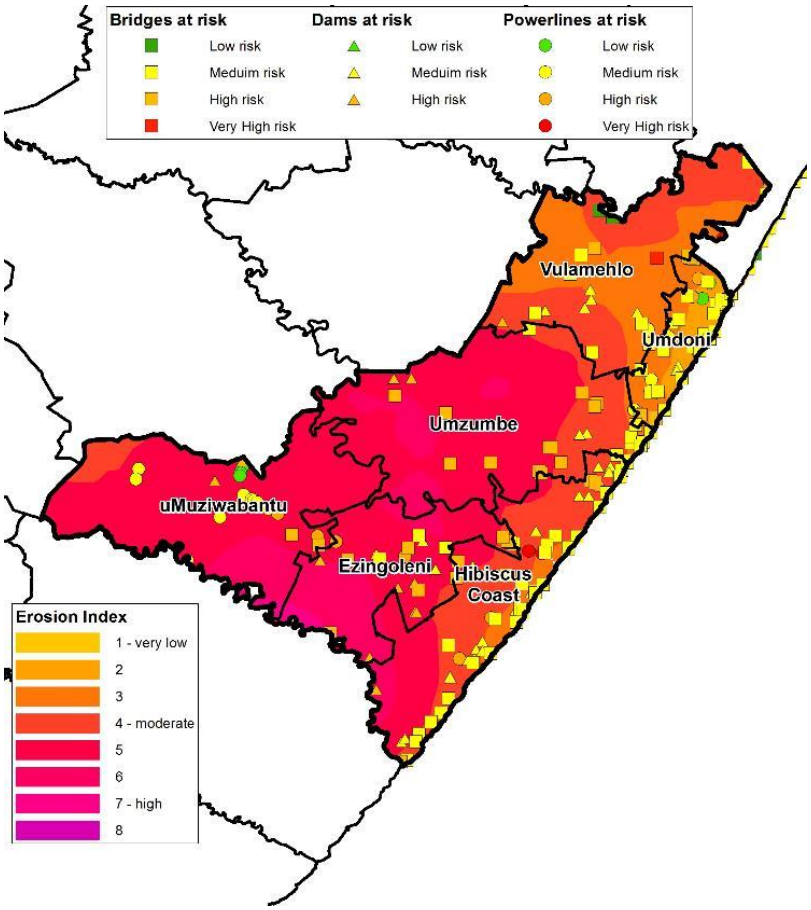
Table 12: Municipal Infrastructure at Risk

Category	Infrastructure Elements
Transportation	Roads (Tarred and Gravel); Culverts; and Bridges.
Buildings	Residential and Commercial/Industrial
Critical Infrastructure	Fire Stations; Hospitals; Educational facilities; Police stations; Facilities for children and the elderly; Emergency medical services; and Water treatment facilities.
Storm & Wastewater Systems	Pipes; Manholes; Storm water Management Facilities; Lift/Pumping Stations; and Outlets.
Water Distribution Network	Water mains under bridges.
Flood Protection Structures	Dams; Flood walls; Bridges and culverts; and Canals.
Human Settlements	Buildings and structures

The transport sector is highlighted due to the fact that it will face impacts related to every aspect of climate change. Extreme temperatures will test the limitations of construction materials. Longer dry periods will cause problems through increased subsidence, while more frequent intense rainfall events increase risk of flooding and erosion. This may impact the collapse of cuttings, embankments culverts, etc.

The management of municipal infrastructure comes with many challenges which are often compounded for smaller municipalities with limited resources. These challenges are posed by the management of ageing infrastructure, population growth or decline, public demands, regulations, liability and risk management. The risk to infrastructure in the UGU DM can, to a large degree, be attributed to general maintenance and the lack thereof. To date most of the municipalities in the UGU DM have implemented a reactive approach towards infrastructure management. In order to provide reliable levels of service in the face of climate change, municipalities will have to review their planning, design and asset management approaches in order to incorporate climate change considerations.

The Long-Term Adaptation Flagship Research Programme [92] shows the infrastructure potentially at risk from flooding events during future extreme rainfall events. Ugu specific impacts from flooding enhancements resulting from climate changes can be seen in Figure 68. It shows a significant proportion of bridge infrastructure along the coast in Hibiscus Coast and Umdoni, the majority of these are medium risk. The impermeable surfaces of the urban areas enhance this flood damage potential and these bridges are at risk from over topping and the subsequent damage caused. The inland LMs present a reduced number of assets at risk compared to the coastal areas. The inland areas UGU DM have a high to extremely high sedimentation yield though heightened river erosion potential[93]. This higher suspended and deposited load may compromise river integrity and storm water systems in the event of high rainfall events. These considerations should be accounted for when planning development and in the management of water resources such as reservoir sedimentation control.



[92] DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa. Pretoria, South Africa.

[93] Msadala, V., Gibson. L., Le Roux, J., Rooseboom, A. Basson, G.R., (2010), Sediment Yield Prediction for South Africa: 2010 Edition, Water Research Commission, WRC Report No. 1765/1/10 ISNB 978-1-4312-0042-9

Figure 68: Ugu infrastructure at risk from flooding events and potential erosion index

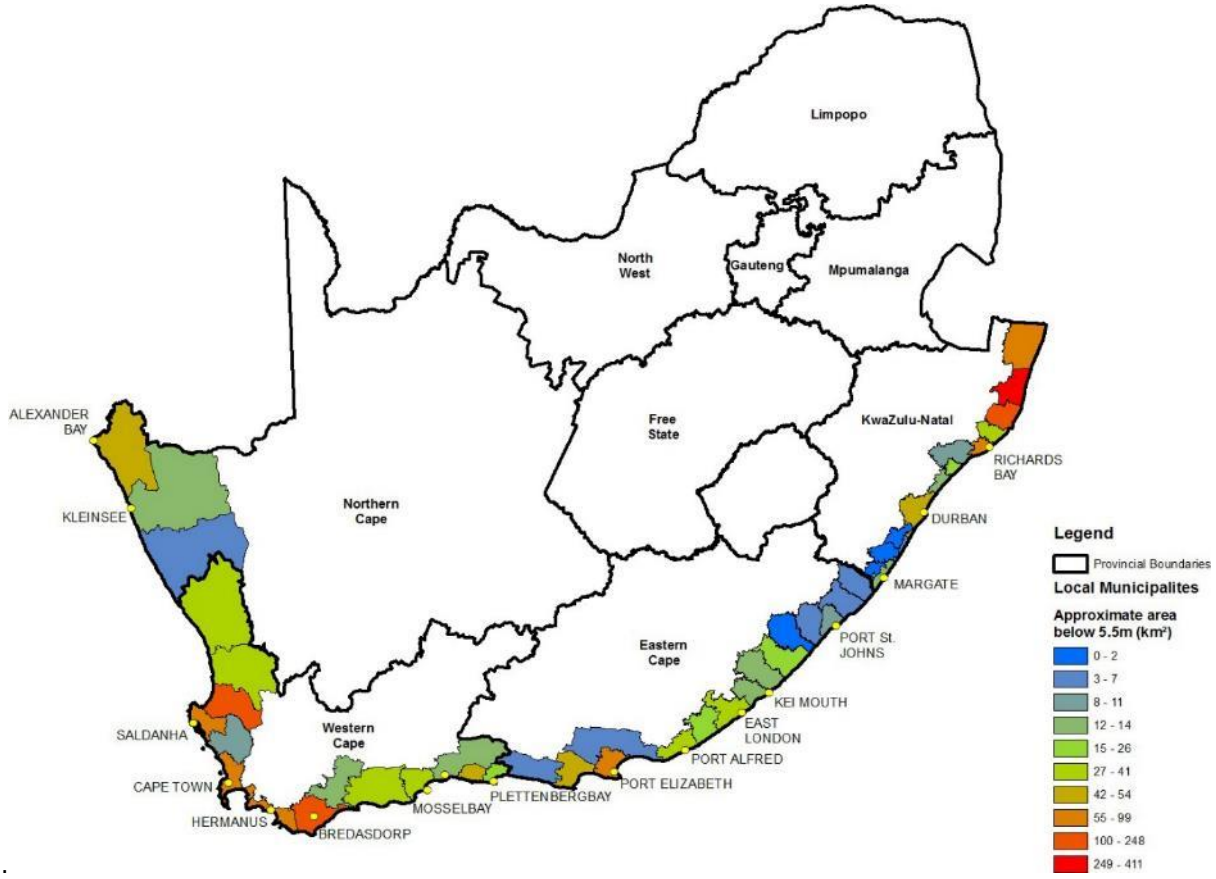
○ Sea-level rise implications for infrastructure

Climate change will result in sea-level rise and potential coastal inundation, land loss and salt water intrusion in the coastal settlements (DEA, 2013). Additionally there are risks associated with increased severe storms, erosion, tidal influence and flooding that further impacts coastal settlements through the loss of property and damage to infrastructure (DEA, 2013; Taylor and Peter, 2014). There are also indirect impacts in the coastal areas through the decline in marine fisheries and tourism revenue.

Climate change impacts are estimated to reduce the value of South African fisheries by approximately 18% with potential shifts in fish stocks impacting particularly on smaller coastal settlements and artisanal fishing communities. These impacts on marine diversity affect livelihoods and coastal economies (DEA, 2013). Extreme weather also endangers fishing boats (DEA, 2013). Small fishing ports may need to upgrade their infrastructure in order to be more resilient to climate hazards. Shipping movements will be affected causing expensive delays and changes in global trade.

Although South Africa is not considered to be particularly vulnerable to the impacts of sea level rise, as compared to other countries such as Bangladesh or Mozambique (Dasgupta, 2007), there are specific local municipalities along the coast that have a relatively significant amount of land that is considered to be at risk from possible sea level rise and increased storm surges (i.e. below 5.5 m above mean sea level), **Invalid source specified.**. This does not include the possible additional impacts in terms of sea water intrusion into coastal aquifers that may impact some coastal communities and existing farming areas.

GIS analysis estimates 2,130 km² of coastline at risk (Figure 69) due to a 1m sea level rise scenario (bearing in mind inundation, wave swash and tidal influences can impact areas below 5.5m). The cumulative impacts of sea level rise and the increased wave swash will render significant areas unsuitable for human settlements. In Ugu DM the municipalities affected will be Hibiscus Coast, uMdoni and Umzumbe with extreme sea level rise impact areas of 15-26km², 3-7km²and 0-2km² respectively.



.

Figure 69: Exposure to eustatic sea-level rise across South Africa's local Municipalities based on extent of land under 5.5 metres (Source: Peter Wilson, Aurecon Group, 2014

This impact would have significant financial sectoral implications for human settlements and tourism in terms of infrastructure and property assets (Table 13).

Table 13: Summary of National Sea-level rise costs 2010-2100 under two scenarios (2010 prices)

	Low (0.5m eustatic rise and swash up to 5.0 metres by 2100)	**High (1m eustatic rise and swash up to 5,5 metres by 2100)**
Public Infrastructure	R11,3bn	R20,7bn
Real Estate and Private Assets	R154.4bn	R273.1bn
Tourism	R45.9bn	R91.8bn
TOTAL	**R211,5bn**	**R385,5bn**

4.3.2.3 Localised sea level rise.

One hourly tidal gauges observations from 1970 indicate a near linear increase in sea level for both Durban (1.23 millimetres/year) and Port Elizabeth (is 2.39 millimetres/year) with a 95% confidence which would equate to 4.18cm (Durban) and 8.13cm (Port Elizabeth) above current (2016) sea level if this trend is maintained until 2050.

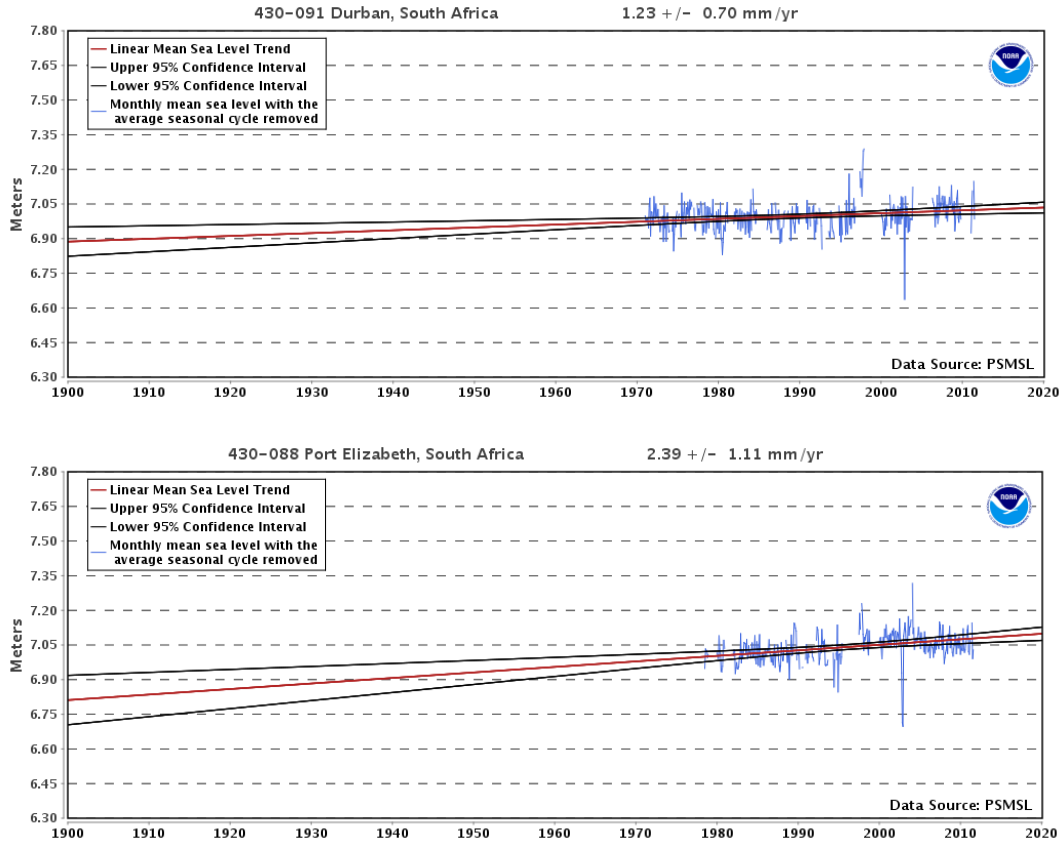
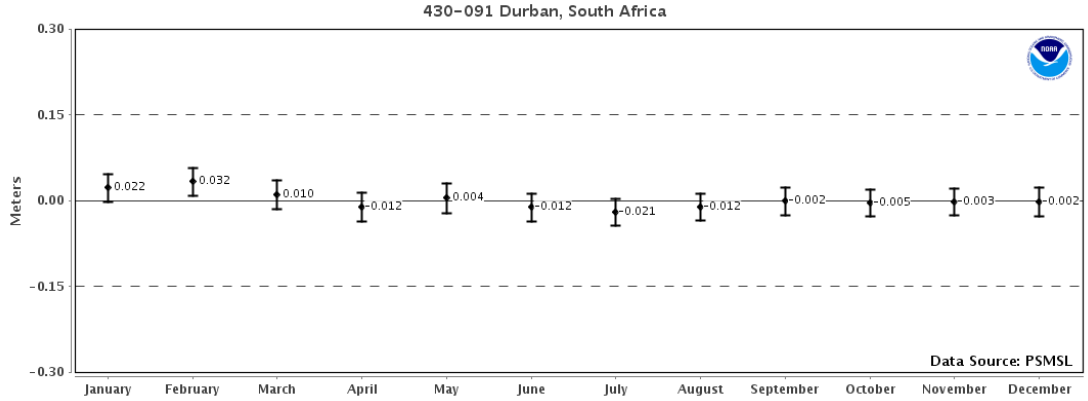


Figure 70: Sea level changes in Durban (top) and Port Elizabeth (bottom) based on tidal gauge readings

This average change in sea level might seem minimal, however the change in baseline sea level will increase the reach and swash from natural inter-annual variability such as the ENSO cycles and irregular fluctuations in coastal ocean temperatures. Changes will also be noted in the seasonal tidal reach. Currently both Durban and Port Elizabeth show heightened tides in late summer, during the month of May and in September. Therefore changes in the underlying forces influencing these seasonal changes "coastal temperatures, salinities, winds, atmospheric pressures, and ocean currents"[94] will alter the seasonal tidal ranges.



[94] National Oceanic and Atmospheric Administration (NOAA), Center for Operational Oceanographic Products and Services, http://tidesandcurrents.noaa.gov/

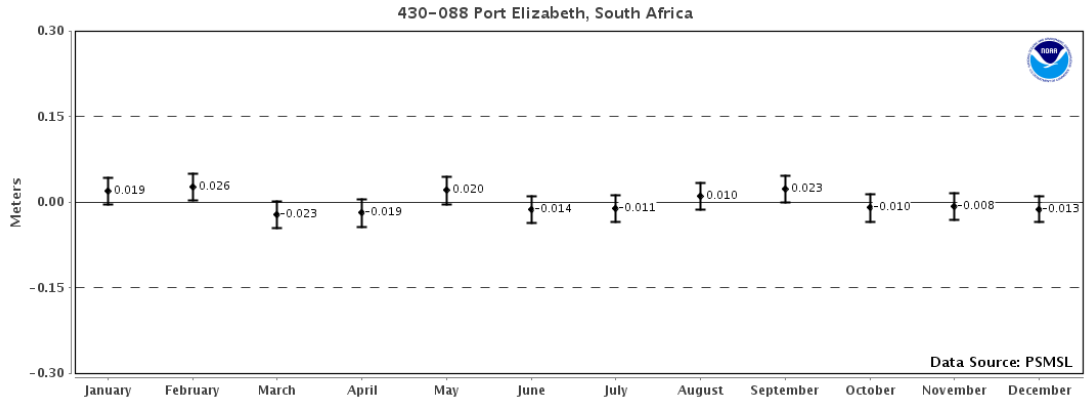


Figure 71: Seasonal tidal ranges for Durban (top) and Port Elizabeth (bottom)[12]

Further changes in ocean temperatures, salinity balance, ocean surface and winds may increase average and seasonal sea levels. When being cognisant of extreme but short lived events such as large ocean storms; sea level may be heightened significantly, at least in the short term, but have massive impacts to the coastal area, assets and infrastructure, and population. Currently there is projected to be an increase in storm intensity through the narrowing of atmospheric pressure gradients (enhancing wind speeds) caused by surface heating and changes in the atmospheric pressure cells. The likelihood of more extreme sea level related impacts is enhanced.

The long term adaptation strategy (LTAS) has projected the impacts to municipal area and population under increasingly sever storm surge run up and tidal variances as influenced by sea level rise scenarios changing.

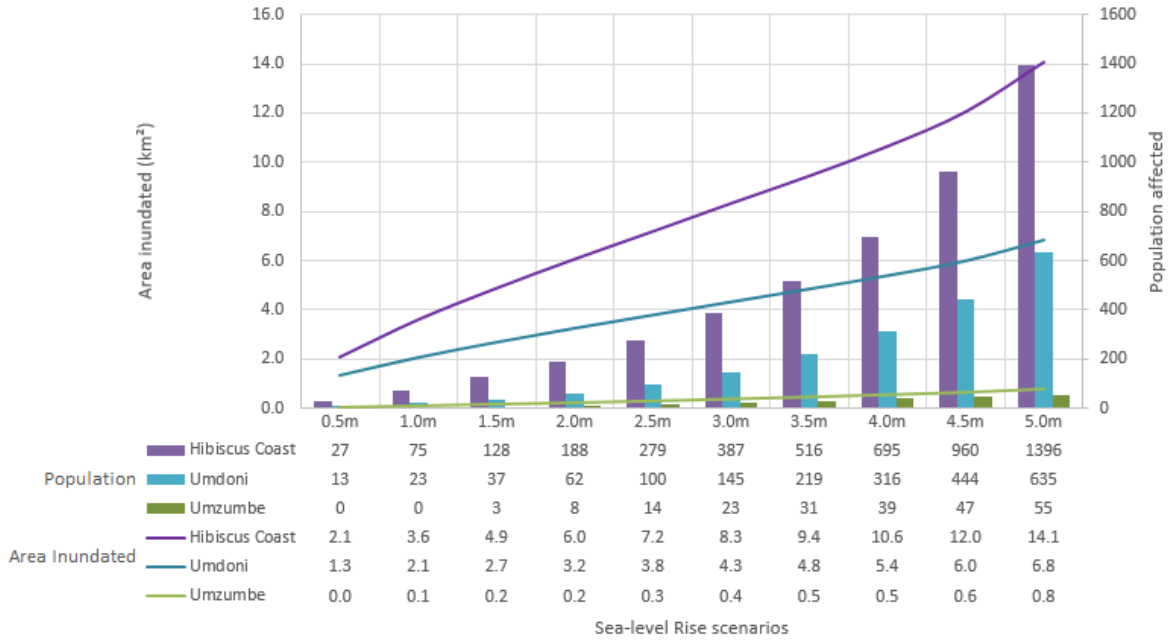


Figure 72: Impacts to area and population by extreme ocean events

The impact of sea level rise is likely to be felt more at a local level based on topography and coastal gradients, rather than whole cities or towns. For example, without any adaptation responses to sea level rise the beachfront area of Scottburgh will experience increased risk to infrastructure and developments such as the Crocworld or the Scottburgh Caravan Park, however areas further inland should be unaffected, other than potentially lost revenue from decrease tourism in the area. The coastlines of KwaZulu-Natal Coast have been identified as one of the most vulnerable coastal settlements (Theron and Rossouw, n.d.)

Table 14: Areas at risk due to sea level rise

Risk focus Area	Risk type	Infrastructure at risk	Property at risk
Izotsha	Inundation up the Zotsha river	Marine Drive and the R61 in extreme scenarios	Properties in Kinsley Drive, Shepstone Road and the developments to the east of Shelly Centre.
Melville	Inundation in Mzumbe river and surrounding area.	R102 and railway over Mzumbe river.	Community to the east of the R102 by Umzumbe railway terminal.
Mtwalume and Fafa	Inundation in the Mtwalume River and river mouth.	N2 and railway	Leuchars Drive, Sidney Gee lane, Marine Place
Scottburgh	Inundation of Mpambanyoni and Mahlongwa River	R102 and railway, Marine Terrace	Properties along Marine Terrace and Bermuda Way

4.3.2.4 Water Resources

Focus Area	Potential Risks
Water resource quality and Conservation	• Inundation of storm water and sewage systems; • Increased peak flow rates; • Changes in groundwater levels; • Shifting flood plains; • Reduced dry weather flow rates; • Increased intensity of precipitation causing intrusion into waste water networks; • Potential for blockages and overflows; • Changes in the mean and peak flow rates of rivers and streams; • Unreliable/insufficient water supply; • Increased risk of contamination; • Salination of water sources; and • Changes/shifting of groundwater used for irrigation.

With variations in rainfall patterns being projected and the local economies' dependency on water availability, water resource management will become a critical component of the UGU DM's climate change strategy. The UGU DM has a significant amount of rural settlements that have already received or have been earmarked for water schemes and relies on groundwater and river resources. The direct effect of climate change on groundwater resources depends upon the change in the volume and distribution of groundwater recharge. Drier, warmer conditions lead to the seasonal deficits in the moisture content of soils and less frequent, but more intense rainfall events occur, the groundwater recharge season may be shortened. In the long term, the projected frequency and intensity of rainfall events in the district may reduce groundwater recharge (increasing over land flow), but the greater variability in rainfall could also mean more frequent and prolonged periods of high or low water levels.

The effects of climate change on groundwater in the UGU DM therefore may include:

- a long term decline in groundwater storage;
- increased frequency and severity of groundwater droughts;
- increased frequency and severity of groundwater-related floods;
- mobilisation of pollutants due to seasonally high water tables and increased overland flow.

The impacts of climate change could increase the cost of providing water supplies, already rising as a result of deteriorating groundwater quality in some areas of the district. It is important to note that groundwater cannot be considered in isolation. The impacts of climate change not necessarily related to groundwater, such as changing land use, population, and borehole density, will have a knock-on effect on groundwater, through changes in water demand.

Based on the longer dry spell duration and warming scenarios projected for the UGU DM, irrigation requirements will increase while water availability may decrease, emphasizing the need for sound catchment management strategies. Water availability will have a significant impact on the agricultural sector due to the reliance on irrigation. With the assurance of water supply already low in areas of the UGU DM, all farming activities and agricultural productivity will be significantly affected.

Scenarios of reduced water availability will also have implications for the management of water quality. As flows decrease, the water quality of river systems will decline rapidly downstream becoming increasingly mineralized. Intensified rainfall events projected as a potential climate change impact in the UGU DM, may also prove a particular problem for water quality, sanitation and soil erosion. Flooding may cause contamination of water sources due to the transportation of topsoil, animal waste, pesticides and fertilizers, sewage and other pollutants into water sources.

4.3.2.5 Terrestrial Biodiversity

Focus Area	Potential Risks
Terrestrial Biodiversity	• Increased erosion and inundation; • Loss of private property and community assets; • Changes to river ecosystems due to erosion and flow rates; • Changes in the distribution of invasive species and associated loss of biodiversity and altered veldfire intensity; • Changes in the geographical distribution of indigenous fauna and flora; • Increased risk of species extinction; • Reduced ecosystem resilience; • Increased stress on ecosystems and ecosystem services.

Natural ecosystems have long demonstrated their adaptive abilities with regards to changes in the environment. Unfortunately the rate of climate change may exceeding the adaptive capacity of some ecosystems within the Ugu DM. In addition to climate change, natural environments within the Ugu DM are also under pressure from human activities, further compromising their ability to absorb the shocks associated with climate change. Therefore the resilience of natural resource systems will often be reliant on communities' ability to make the necessary behavioural adjustments.

The vulnerability of the Ugu DM's biodiversity to climate change is compounded by limited access to capital and technology, and lack of human and financial resources for implementing protective strategies. Projected climate change impacts relevant to biodiversity in the Ugu DM includes:

- Changes to ecosystems due to variable rainfall patterns and erosion;
- Changes in the distribution of invasive species and associated loss of biodiversity and altered veldfire intensity;
- Potential changes in the geographical distribution of indigenous fauna and flora;

- Increased risk of species extinction;
- Reduced ecosystem resilience; and
- Increased stress on ecosystems and ecosystem services.

The long term impacts of climate change on terrestrial biodiversity are complex and warrant more focussed research. Climate variations are expected to have a significant impact on agriculture within the UGU DM due to the adverse impacts on terrestrial systems and the provision of ecosystems services.

The low and high risk climate futures following climate scenarios developed for South Africa for approximately 2050: low risk (Best case scenario) smallest predicted increases in temperature and changes in rainfall, medium risk (median scenario) middle of the range predicted increases in temperature increases and changes in rainfall, High risk (worst case scenario) greatest predicted increases in temperature and changes in rainfall (Figure 73).

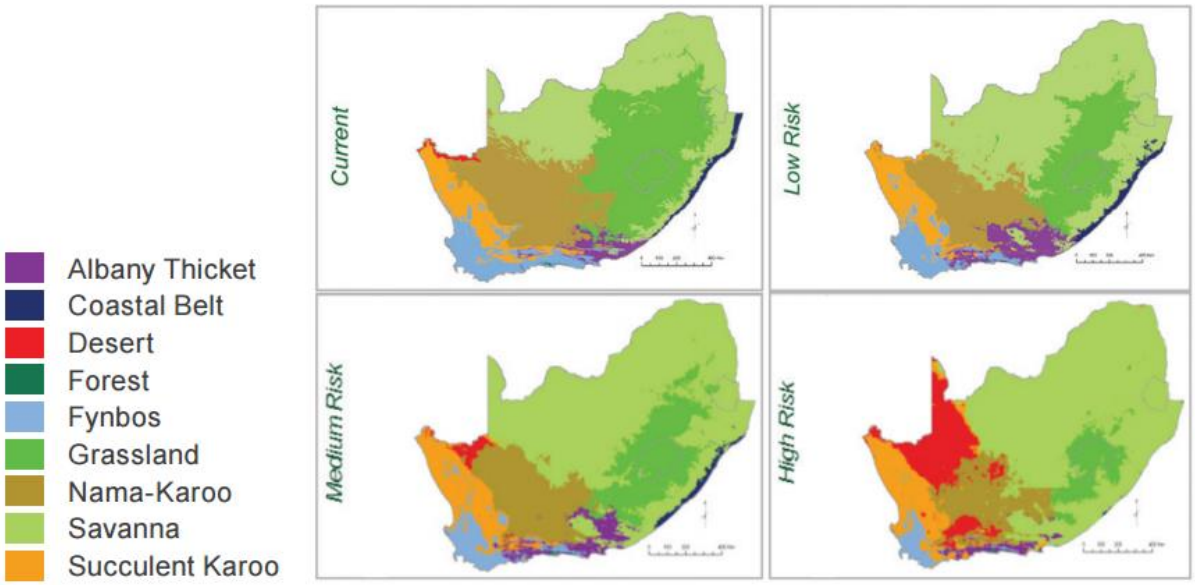


Figure 73: Current and projected biome changes under various 2050 climate futures[95]

In the presence of greater average temperatures and more variable and generally reduced rainfall and heightened atmospheric CO_2 concentrations, all the projected scenarios show a tendency toward the expansion of Savanna areas in the South African landscape. Expansive savanna biomes are resilient and currently endure extreme temperatures but will be sensitive to changes in precipitation volumes and timings. The game in the savanna areas are less resilient as the dependency on water availability in water stress periods leads to heightened competition among game and may compromise ecosystem stability (Table 15).

[95] DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa. Pretoria, South Africa

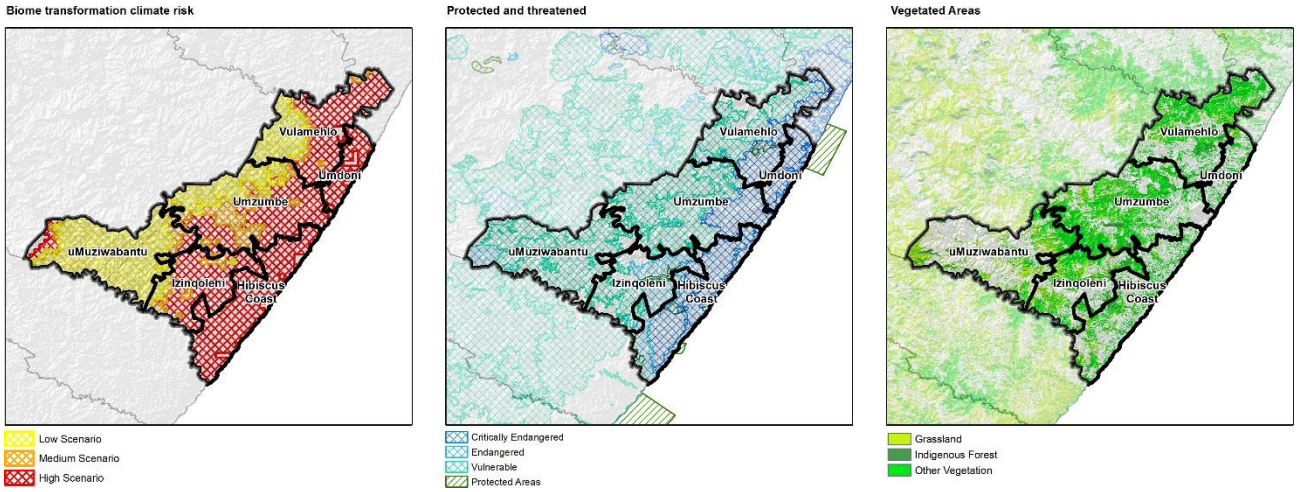


Figure 74: Biome impact risk potential and current vegetation status

Varying biomes have characteristic ranges of optimum patterns of temperature and rainfall values. Analysis of these range changes is presented at the Ugu scale for biomes under the high (worst case), medium (median case) and low risk (best case) climate rainfall and temperature scenarios as compiled by SANBI (Guy Midgley and Danni Guo). Under varying scenarios one biome may become climatically suited to another biome type and thereby introducing transformation climate related stresses.

Biome transformation is highlighted in the savanna biome dominating in the high risk, worst case scenario.
The critically endangered coastal vegetation areas are only transformed under the high risk scenario. The inland areas are exposed to savanna climate suitability transformation under both the low and medium risk scenarios. The transformation may compromise ecosystem sustainability particularly as they encroach into the vulnerable and endangered areas vegetation areas closer to the coast (Figure 74).

The disruption to the biome encompassing large natural areas is recognised as a challenge to the continued existence of species and natural ecosystems with further consequences to consider being changes in fire frequency though biomass changes, land degradation through alien vegetation intrusion, changes to hydrological cycles and potential water regime disruption.

Species specific impacts for game farms and faunal biodiversity are listed below.

Table 15: Fauna climate profiles and likely future stressor

Species	Climate sensitivity	Climate impacts	Ecological impacts
Birds	Birds have a significant advantage in coping with climate changes with increased mobility. Climate impacts will impact area suitability based on resources they need.	Vegetation biome changes as a result of climate changes will change distributions and increase species competition.	The most critical factor is the habitat integrity and where this is insufficient, displacement or loss of species will occur.
Blue duiker	Duikers are very adaptable, omnivorous and live in forest/bush areas. They receive most of the moisture from the plants they eat.	Climate changes impacting the biomes and changing the ecosystem could increase the exposure of duikers.	Changes in the biomes may limit the habitat of duiker and force them into more exposed areas for browsing.

Species	Climate sensitivity	Climate impacts	Ecological impacts
Bush pig	Bush Pigs live in forests, woodland and riverine areas foraging for roots and crops. Bush pigs are already a problem for farmers in the area as they unearth crops.	As rather robust and adaptive animals, water availability will likely be the largest climate stress increase temperature will change the times of peak activity during the day	Changes in the biomes and agriculture expansion may limit the habitat of bush pigs and increase exposure between them and humans.
Crocodile	Crocodiles are semiaquatic and therefore rely heavily on the availability of water resources for hunting. Crocodiles are cold blooded and are sensitive to cold temperatures.	Increasing temperatures may actually be beneficial to crocodiles which would need to spend less time basking. The increased variability of precipitation will significantly compromise crocodile's habitat.	Decreased water availability will increase densification of crocodiles in the remaining viable waterholes. This will increase competition between individuals and ultimately reduce populations.
Elephant	Elephants are very adaptable and can survive in a multitude of areas and temperatures. They however prefer to stay in areas with adequate water supply.	Water availability will be the largest climate stress for elephants, though the increase in temperatures will require additional thermal regulation	Elephants are significant influencers of the ecosystem. Increased temperatures and decreased water availability will reduce the activity of elephants and therefore reduce the impact them have to mould the ecosystem.
Hippopotamus	Hippos are semiaquatic and therefore rely heavily on the availability of water resources. Procreation and birth occur in water. They remain in water during the heat of the day and graze on land during the cooler evening/night-time temperatures.	Decreased water availability will have a significant detrimental impact on hippo population. Increased temperatures will also increase the times spent in the water body and decrease the time on land in the evenings.	Reduced water availability will compromise procreation and could lead to reduced population numbers
Large cats (Lion, Cheetah, Leopard)	Large cats can be found in savannas, grasslands, dense bush and woodlands. If water is available, they will drink daily, though lions can survive 5 days without it. And they can also get needed water from the stomach contents of their prey.	Increased temperatures will decrease the active duration during the day and could change hunting timing. It will also increase the exertion required when hunting. The limitation of water resources will change the distribution of prey and they will need to adapt.	Changes on hunting times and ranges may not coincide with the movement patterns of their prey and therefore hunt success could be compromised or the encroachment into territories of other large cats.
Large grazers (Eland, Kudu, Impala, Waterbuck, Zebra)	Require water almost daily either from watering holes/rivers or from moisture in eaten vegetation. They are not particularly selective of the vegetation they eat and will browse grasses or shrubs	The decreased water availability and shift from grasses to savanna my put the buffalo at risk. Increased temperatures will reduce the time the animals are active while they seek shade during the hottest part of the day.	The limited water availability may require additional grazing to achieve daily water needs thereby compromising ecosystem sustainability. Should there be a decrease in population, further stress be placed on larger carnivores.

Species	Climate sensitivity	Climate impacts	Ecological impacts
Reptiles and amphibians (Snakes and frogs)	Ectothermy of species means that reptiles and amphibian are highly sensitive to temperature changes. Water based habitats will also be a very limiting factor as to species sensitivity.	Different species will respond in varying ways to increased temperatures though changes in precipitation regimes will almost certainly prove to be detrimental.	The loss or degradation of habitat will change species survivability and could result in range adaptive.
Rhinoceros	Rhinos require water daily and will visit watering holes and roll in the mud to cool themselves. They eat grasses as well as small foliage of bushes and low trees.	Reduced water availability and increased temperatures will compromise the rhino's ability to cool itself with mud. They will therefore need to move further to find adequate water supply.	Increased water and temperature stress will further compromise the rhinos preferred habitat.
Spotted hyena	Hyenas are resilient and skilled hunters and scavengers. They have very efficient digestive systems which are able to digest all but the hair of their prey.	Hyenas are more active and hunt at night. They will be less impacted by the increased daytime temperatures. Though they need little water, their prey is reliant on water availability and water stress will change hunting ranges for hyenas.	Impacts to the range of their prey will compromise the hyena's food supply as migration will result in encroaching on the territory of another hyena pack.
Vervet monkeys	Vervet monkey's habitat consists of a wide variety of areas such as woodland and open savannahs. They are dependent on water availability and trees for food and cover.	Water availability will be the largest climate stress for vervet monkeys, though access to food sources will require adaptation.	They are currently also found in urban areas and farms were they often damage crops. Increased impacts to their preferred habitat will increase these encounters.

- **Estuaries at risk**

There are 42 estuaries along the coastal strip of Ugu which are highly vulnerable because of development of the coast and sea level rise. Of these 42 estuaries 37 are closed to the sea for part of the year and are therefore classified as barrier lagoons instead of true estuaries. Estuaries are highly variable systems but climate change has the potential to alter them beyond their current variability. Rising sea levels can reduce freshwater availability in an estuary which can have an impact on agriculture. Changes in salinity can also impact freshwater and marine organisms. The depth of an estuary relies heavily on sea level. Sea level rise also has other impacts on estuaries such as increased vulnerability of floodplains which results in bigger floods during storms or permanent submergence of the surrounding ecological settings and built infrastructure[96]**.** The severity of impacts of sea level rise on estuaries in Ugu varies as shown in the table below.

Impact	Priority estuaries	Nonpriority estuaries
Very little impact	Damba	Mzimayi, Nkomba, Uvuzana, Zolwane, Tongazi, Bilanhlolo, Kongweni, Mhlangamkulu, Mtentweni, Mvutshini and Vungu

[96] Estuaries and climate change , water Research laboratory

Impact	Priority estuaries	Nonpriority estuaries
Low impact	Mtamvuna	Ku-Boboyi, Kaba, Mbango, Sandlundlu, Umhlangankulu, Mbizana and Mkumbane
Medium impact	Intshambili, Zotsha and Mzimkulu	Mzinto, Fafa, Kandandhlovu, Mhlangeni and Mvuzi
High impact	Mpenjati, Koshwana, Kwa-Makosi, Mfazazana and Mhlabatshane	Mahlongwa, Mnamfu, Boboyi, Mdesingane, Mhlungwa, Mpambanyoni, Mtwalume, Mzumbe and Sezela

The Hibiscus Coast Local Municipality has an Estuary Management Plan set out to sustain the natural and built environment. This project has a total estimated cost of R200 000. Umdoni Local Municipality has a River/Estuary Rehabilitation Plan in place. The plan includes projects such as alien invasive vegetation clearing which reduces degradation of estuaries and rivers. Estuaries in Umzumbe Local Municipality are facing pressures from development in the coastal zone. Improved functionality of Ugu's estuarine systems will assist the municipality in combating climate change by providing ecosystem services such as carbon sequestration and flood control.

4.3.2.6 Disaster Management

Focus Area	Potential Risks
Disaster Management/Health	• Changes in geographical range and seasonality of vector-borne diseases - Malaria; • Increased incidence of food and water-borne diseases due to increased temperatures; • Health impacts related to extreme events; • Intrusion of contaminants and pollutants into water sources due to excessive rainfall; • Increased demands on emergency response and recovery operations; and • Adverse impacts on public safety and tourism, impacting regional economic performance.

An effective disaster risk management function within the district and local municipalities will be a fundamental component in improving resilience to climate change. On a national level South Africa possesses the necessary mechanisms to facilitate an integrated approach to disaster management. These mechanisms include the National Disaster Management Act (57 of 2002) and the National Disaster Management Framework (2005).

The draft national adaptation strategy has highlighted specific climate impacts on human settlements to various climate hazards as a baseline strategic level assessment.

Overall warming	Heat waves and drought	Storms and extreme rainfall weather events	Sea level rise
Intensified heat island effect in urban areas.	Reduced water availability and water quality issues.	Infrastructure damages and impacts on households, business, etc.	Higher tides and more intense storm surges
Increased energy demand for cooling.	Increased risk of heat-related mortality, especially for the elderly, chronically	Increased risk of deaths, injuries and post-traumatic stress disorders.	Decreased availability of fresh water due to intrusion of salt water into aquifers.

Overall warming	Heat waves and drought	Storms and extreme rainfall weather events	Sea level rise
	sick, very young and poor		
Declining air quality in cities from energy and waste pollution.	Food shortages as crops and livestock die due to water shortages.	Adverse effects on quality of surface and groundwater, and contamination of water supply if infrastructure is damaged.	Increased coastal erosion and damage to infrastructure.
Reduced energy demand for heating.	Implementation of water restrictions.	Large displacement of people and migration to urban areas as infrastructure is damaged and livelihoods are lost.	Impacts on ecosystem services (e.g. mangrove swamps and coastal wetlands).
Reduced disruption to transport due to flooding, hailstorms, ice, etc.	Increased migration from rural to urban areas	Loss of property and withdrawal of risk coverage in vulnerable areas by private insurers.	

The link between disaster management and climate change cannot be ignored and much of the district's biodiversity, infrastructure, industries and communities will be increasingly prone to the impacts of natural disasters associated with climate change. This will place additional pressure on current disaster management resources. These high level impacts are manifest on the local scale as influences on disaster risk priorities.

At present the District maintains a largely reactive approach towards disaster management, apart from limited awareness campaigns, especially at a local level. This can be largely attributed to a lack of institutional resources. Although the proper application of the Disaster Management Act and Framework could provide a platform for addressing climate change response and adaptation within the district, it is not currently utilized as such.

Climate change is directly associated with the potential increase of the following hazards in the UGU DM

Storms; Flooding; Drought; Epidemics Veldfires.

However, in the presence of increased temperatures and more variable and shifting rainfall patterns, many disaster events may shift in impact potential and locations, either as a direct result of climate changes or as an indirect result of a system's integrity being compromised though climate changes. Often these changes will compromise communities that are ill-equipped and unprepared to the timing and extent of these impacts.

Table 16: Potential climate change impacts on priority risks[97]

Hazard Type	Hazard	Climate Driver	Climate Change influence
Weather	**Drought**	Annual precipitation volumes	Inter-annual variably is increased and there is a heightened potential for drought occurrence. There is also an increased dry spell duration adding further pressure to water resources.
	Floods	Increase in extreme rainfall events	Increased extreme precipitation and higher intensity will result in flash flooding potential in areas that may not currently experience flood events. Furthermore it will increase hail and severe storm potential.
	Hail Storms		
	Severe weather		
	Storm surges	Increase in oceanic storms	Oceanic storm increases will change the storm surge potential. The impact on the coastline is determined by the level of coastal degradation.
Pollution	**Air pollution**	No direct driver	While there is no direct correlation between changing climates and pollution; compromising of environment and societal resilience by impacts of climate changes may alter service delivery priorities and to the potential neglecting of proper and sustainable waste disposal.
	Hazmat by rail		
	Hazmat by road		
	Industrial waste		
	Oil pollution		
	Waste and disposal		
	Water pollution		
Infrastructure	**Dam failure**	Increase in extreme rainfall events	While extreme rainfall in a catchment can put pressure on dam infrastructure, more significant is the potential of increased intensity rainfall to increase erosion (particularly in degraded landscapes) leading to an increase in sedimentation at the dam wall. If not maintained, this will decrease capacity and place additional pressure on the dam wall.
	Power outages	Increased temperatures	Increased temperatures leads to an increase in cooling demand and therefore an increase in energy demand. Increased temperatures also decreases the energy generation efficiency of solar facilities and therefore increasing power outage susceptibility.
	Tidal Wave	No direct driver	Caused by an earthquake on the ocean floor, there is no climatic driver to Tsunamis. There may be heightened impacts caused by their occurrence in degraded coastal area lacking natural vegetation and where development has occurred too close to the high water mark. The rise in sea-level will further increase the impact of Tsunamis.
Environmental	**Deforestation**	Changes to general climate	Changes to climate will compromise ecosystem services and biodiversity sustainability and will impact the ability of natural areas to recover thus enhancing the negative consequences of deforestation.
	Land Degradation		
	Fires	Longer heatwaves, extreme temperature days and longer dry spell duration.	Longer heatwaves and generally increased dry spell duration increases wild fire risk. There will be minimal direct climate impact of urban fires though the supply of municipal hydrants may be compromised in water scarce periods.

[97] IPCC AR3 - Working Group II: Impacts, Adaptation and Vulnerability - Chapter 9.7. Infectious Diseases, http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=358#tab92
IPCC AR5 - Working Group II - Chapter 11 Human Health: Impacts, Adaptation, and Co-Benefits, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap11_FINAL.pdf

Hazard Type	Hazard	Climate Driver	Climate Change influence
Disease (priority identified by Disaster Management plan)	**Cholera**	Increased temperatures, extreme rainfall	More frequent and intense heat waves with extreme rainfall will increased the spread of cholera.
	Dysentery/Shigella	Increased temperatures and rainfall	Increased temperatures/rainfall/humidity are correlated with the incidence of dysentery.
	HIV	No direct driver	Climate changes may not directly impact HIV or measles prevalence/exposure but will alter the exposure of communities to hazards and will change sectors such as water supply and agriculture. This in turn will impact the treatment of those currently affected.
	Measles		
	Polio	Increased temperatures	Increased temperatures and longer heatwaves may increase the transmission potential of Polio, particularly in summer months
	Rabies	Heat waves and drought	Increased temperatures/heatwaves and heightened drought potential decreasing food availability may result in infected animals closer to human areas.
	Tuberculosis	Rainfall changes	Pressure on water resources may bring livestock and wildlife in closer proximity and increase transmission and exposure to humans
Disease (non-priority)	**Malaria (Mosquito borne)**	Increased temperatures, increased precipitation/ extremes	Warmer temperatures and more humidity/precipitation enhances mosquito breeding potential. The changes in contraction potential are however highly variable on a local scale.
	Dengue (Mosquito borne)	Increased temperatures, increased precipitation/ extremes	Warmer temperatures and more humidity/precipitation enhances mosquito breeding potential. There is a general trend of increased prevalence and contraction under increased temperature/precipitation/humidity changes.
	Encephalitis (Tick borne)	Increased temperatures, humidity	Tick activity increases in higher temperatures/humidity and therefore transmission potential is increased in the presence of climate changes.
	Lyme (Tick borne)	Increased temperatures, humidity	Increased temperatures and humidity under climate changes may increase tick development cycles, increase population growth/density and change range due to competition.
	Haemorrhagic Fever (Rodent borne)	Seasonal cycles, increased temperatures, rainfall/ extremes	Warmer winter favours rodent survival and increased rainfall leads to an increase in food availability and population size. There is a strong correlation to transmission.
	Sleeping sickness	Increased temperatures	Increased temperatures will increase the range of the tsetse fly and the transmission potential to humans.
	General	Increased temperatures/ precipitation/ extremes	In general with increased temperatures there is expanded distribution, Increased vector population growth and a change in susceptibility to some diseases as well as an increased rate of extrinsic incubation and increased transmission season of pathogens. Increased rainfall can change population size and change habitat areas.

4.3.2.7 Agriculture

Focus Area	Potential Risks
Agriculture	• Projected climate change may lead to inferior crop yields and poor veld conditions; • Reduction in and degradation of animal habitats; • Lack of livestock feed and drinking water; • Increase in disease outbreak and increased vulnerability to predation; • Increased risk of soil erosion; • Annual and perennial crop losses; • Damage to crop quality; and • Disruption of animal breeding and/or crop cycles. • Reduce employment opportunities in commercial sector; and • Increased livelihood and food insecurity among subsistence farmers.

The important crop and livestock production in Ugu District Municipality include Sugar cane, Bananas, Macadamias, Vegetables, Maize, Amadumbe, Beans and timber. Regarding livestock there are Eggs, Broilers, and cattle (Beef/dairy). There are a large number of smallholder maize and livestock farmers[98].

Climatic vulnerability currently experienced in the agriculture sector will be exacerbated by the projected climate changes of increased temperatures (and associated extremes) and decreased precipitation (and increased extreme events and variability). The district's agricultural sector will prove sensitive to projected shifts in climatic patterns, adding to existing environmental degradation and rainfall variability. Local climate change projections and related impacts are indicating that, without intervention, crop yields will be adversely affected by climate change in the Ugu DM. It is important to note that according to research, while simultaneous change in rainfall and temperature will adversely affect agricultural activities, temperature expected to have a greater bearing on the negative impacts than a reduction (enhanced variability) in rainfall alone[99]. One of the most significant findings form the Fiscal and Financial Commission's (FFC) research is variable impacts across different types of farming, with crop farming being the most vulnerable to climate change and mixed farming the least, motivating diversification as a potential adaptation strategy.

Increased soil evaporation will cause an increase in water stress of rain fed horticultural crops and increase the water demand of irrigated crops. Where pastures are currently irrigated these may come under pressure due to competing demands for water and increased variability in rainfall. Rain-fed pasture lands may also experience bush encroachment due to increasing levels of CO_2[100]. Livestock production will be effected by climate change both directly, through heat stress[101] and humidity[102], and indirectly, such as impact on feed production[103].

Inland shifts in the climatically optimum growth areas for sugarcane may be expected by 2030-2050 (intermediate future). In addition the sugarcane harvest-to-harvest cycle could reduce by 3–5 months (i.e. by 20–30%) by the intermediate future while yields are projected to increase by 5–15 t/ha along the

[98] Stats SA (Statistics South Africa). 2007. Census of commercial agriculture, Report No. 11-02-01 (2007), Pretoria RSA.
[99] Turple and Visser. 2013. Chapter 4: The Impact of Climate Change on South Africa's Rural Areas. 2013/14 Submission for the division of revenue, FFC.
[100] Bond W. J., and Midgley G. F. 2012 Carbon dioxide and the uneasy interactions of trees and savannah grasses. Philosophical Transactions of the Royal Society B, Volume 367, 301-612.
[101] Nesamvuni, E., Lekalakala, R., Norris, D., and Ngambi, J. W. 2012. Effects of climate change on dairy cattle, South Africa. African Journal of Agricultural Research 7(26): 3867–3872.
[102] Archer van Garderen, E. R. M. 2011. Reconsidering cattle farming in Southern Africa under a changing climate. Weather, Climate & Society, 3(4): 249–253.
[103] Musvoto, C., Thambiran, T., Padayachi, Y. and Davis, C. 2015: Agro-Food Processing Industry: Value Chain Based Assessment for Mitigation and Adaptation, CSIR-NRE Report, Pretoria, South Africa

coast and by up to 20–30 t/ha in the inland growing areas[104]. Sensitivity analyses have found that when a temperature increase of 2°C is coupled with simultaneous with a 10% rainfall decrease, yields decreased by about 7%. Under increased rainfall scenarios, sugarcane yields are modelled to increase, yet the variability in rainfall will alter this yield potential between seasons. The climatically suitable areas for sugarcane will expand further inland in KwaZulu-Natal[105].

Plantation in Ugu DM consist predominately of pine specie. Modelling studies have shown that pine species are less sensitive to rising temperatures than eucalypts and that an increase in rainfall may offset the negative impact of rising temperatures[106]. Commercial forestry supplies inputs for a number of downstream industries and is an important strategic employer in rural areas where there is high unemployment[107]. The major constraint to any expansion is the competition for water and land. Any expansion in commercial forestry requires licensing cognisant of these constraints.
Changes in climate may indirectly increase vulnerability in commercial plantations through:

- the survival and spread of insects and pathogens[108];
- fire regime changes influenced by lightning strike potential through increased extreme storms[110]. Increased temperatures and enhanced evapotranspiration will precondition vegetation to burning.

The implementation of adaptation measures require that planned responses are implemented in advance of the impacts of climate change due to the long rotation of commercial planation species. These measure should be assimilated into sustainable forest management plans[109].

There is evidence that smallholder subsistence farmers are more vulnerable to climate change than commercial farmers due to limited access to resources. This raises concern in regard to food security where many smallholders are reliant on maize production. Maize yields have been simulated to be sensitive to both climate and CO_2 fertilisation, with doubled CO_2 potentially counteracting some of the reduced productivity associated with a 2°C temperature rise[110]. Changing rainfall patterns have been found to cause a likely a decline in yields[111]. Without adaptation methods the increased soil evaporation under a warmer drier climate would negatively impact smallholder maize production[112].

[104] Schulze R.E. 2010. Atlas of Climate Change and the South African Agricultural Sector: a 2010 Perspective. Department of Agriculture, Forestry and Fisheries, Chapter 7.4: 257–266. Pretoria, RSA.
[105] DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Agriculture and Forestry Sectors in South Africa. Pretoria, South Africa.
[106] Warburton, M. L. and Schulze, R. E. 2008. Potential impacts of climate change on climatically suitable growth areas of Pinus and Eucalyptus: results from a sensitivity study in South Africa. Southern Forests, vol. 70, (1), 27–36.
[107] Naidoo, S. Davis, C. & Archer van Garderen, E. 2013. Forests, rangelands and climate change in southern Africa. Forests and Climate Change Working Paper No. 12. Rome, Food and Agriculture Organization of the United Nations
[108] DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Agriculture and Forestry Sectors in South Africa. Pretoria, South Africa.
[109] Lötter, D., & Le Maitre, D. 2014. Modelling the distribution of *Aspalathus linearis* (Rooibos tea): implications of climate change for livelihoods dependent on both cultivation and harvesting from the wild. Ecology and Evolution, 4 (8), 1209-1221.
[110] Walker N.J. and Schulze R.E. 2008. Climate change impacts on agro-ecosystem sustainability across three climate regions in the maize belt of South Africa. Agriculture, Ecosystems and Environment 124(1–2): 114–124.
[111] Zinyengere, N., Crespo, O., & Hachigonta, S. (2013) Crop response to climate change in southern Africa: A comprehensive review. Global and Planetary Change 111, 118-126.
[112] DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Agriculture and Forestry Sectors in South Africa. Pretoria, South Africa.

Table 17: Agricultural product climate profiles and likely future stressor[113]

Product	Preferred climatic conditions	Future climate impact
Amadumbe	Requires an optimum temperature of between 13 and 30°C. Warm conditions are preferred as it cannot withstand freezing conditions. Can tolerate high rainfall areas however there should be good drainage as waterlogging will damage the crops. For optimal growth rainfall of 1 400 to 2 000 mm is required for the growing season. Planting season is November and the Amadumbe plants mature in about 8 to 10 months from planting.	Amadumbe is able to tolerate warmer weather, though when temperatures get to extreme ranges the plant may suffer. The variability in the rainfall that is projected may have a detrimental impact to the crop through insufficient or highly variable water supply.
Banana	Sub-optimal, subtropical conditions are ideal for growing bananas. The crops are highly dependent on rainfall (100mm/month) that is evenly distributed and production will be low during low rainfall periods and high during high rainfall periods. Requires warm, humid conditions that is frost free. Optimal temperature for production range between 22 and 31°C and flourish under uniform warm to hot conditions. The growth will be impeded if temperatures drop below 16°C and will eventually stop at 10°C. Harvesting period for crops is throughout the year (Jan-Dec). Banana production in KZN takes place between Port Edward and Port Shepstone due to its ideal climatic conditions.	Bananas will likely thrive in the increase temperatures projected, though erratic extreme temperature days may have a detrimental effect. The variability in the rainfall within and between years may compromise the crop. Farmers should make use of seasonal forecasts where available.
Beans	Beans are warm-season crop that are extremely sensitive to frost and hot conditions. Temperature require for optimal production range between 15 °C to 27 °C. Temperatures of below 5°C and above 35°C will yield poor quality.	Increased temperatures will have detrimental effects of the quality of Beans and there may be areas where growing them is no longer suitable. The crop will suffer through extreme days and extended heat waves.
Macadamias	Optimal temperature range between 25°C - 35°C, however if temperature are above 30°C for long periods growth will be the growth will be distorted. Full grown trees can survive under cold conditions up to 3°C, but if temperatures drop below 5°C young trees will die. Rainfall of between 800 – 1200mm per annum is sufficient for production, and can be supplemented by irrigation if needs be . Ugu is the largest macadamia producer in the KZN province owing to its optimal climatic conditions.	Macadamias will likely thrive in the increase temperatures projected, though the projected intended heat waves will have detrimental effects on the crop. The variability in the rainfall within and between years may compromise the crop. Farmers should make use of seasonal forecasts where available.
Maize	Temperatures ranges needed for maize production are wide but 18°C to 20°C is optimum. Cooler temperatures prolong the maturating of the crop but frost is damaging. Maize is able to grow in temperatures up to 45°C if sufficient water is available. Maize needs approximately 350 to 450mm during growth. This can be supplemented with irrigated water to increase yield.	The increased temperatures projected may affect the crop on the very extreme temperature days. The water requirement should be sufficient for the maturing of the crop, though it may be less reliable and if irrigation is needed, it'll add additional pressure to water resources.

[113] Information obtained from

DEA (Department of Environmental Affairs). 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Agriculture and Forestry Sectors in South Africa. Pretoria, South Africa

Department of forestry and fisheries - http://www.daff.gov.za/daffweb3/Resource-Centre

Food and Agricultural Organisation and the United Nations - http://www.fao.org/

National Center for Biotechnology Information http://www.ncbi.nlm.nih.gov/

Product	Preferred climatic conditions	Future climate impact
Onions	Onions grow best between 18°C and 22°C. Temperatures of 25°C to 27°C will promote bulb formation. Temperatures of 8°C to 13°C will induce flowering. Onions will need significant water and irrigation is required during the growing season. Planting season is during late summer.	It is unlikely that crop will experience temperatures below 18°C often. Once bulbing has taken place, the onions are more able to tolerate warmer temperatures, yet extreme high temperatures may decrease the quality of the yield. The changing rainfall regime may not impact the crop though the resulting water stress may limit the availability of water resources of irrigation.
Sugar Cane	Requires tropical climate but also grows under subtropical conditions. The temperature for optimal growth range between 20 and 35°C. Sugar cane requires 1100 to 1500mm of rainfall during its vegetative growth period after which a dry period is needed for ripening. The ideal planting period is during autumn (mid Feb – April) and under rain fed conditions from September to November as the soil should be water soaked. The plantations are harvested after 12 – 16 months when the crops have reached a height of 2 – 4m.	Sugar cane should thrive in the increase temperatures projected, though erratic extreme temperature days may have a detrimental effect. It has already been show that sugar cane yields are sensitive to variability in rainfall. Though there is increased rainfall projected, it will be highly variable and farmers should make use of seasonal forecasts where available.
Tomatoes	Average daily mean of between 20°C and 24°C provides optimum quality. Quality determinates below 12°C and above 35°C. Excess rain can result in the occurrence and spread of foliar diseases. Irrigation is recommended. Planning generally occurs late winter in warmer regions.	It is unlikely that crop quality will suffer from temperatures below 12°C. Yet the expected higher temperatures will decrease the quality of the yield. The changing rainfall regime may not impact the crop though the resulting water stress may limit the availability of water resources of irrigation.
Cattle (Beef/Dairy)	Beef cows thrive at an ambient temperature range of about 15°C to 25°C. The water needs of cows is reliant on the temperature. Above 35°C the water requirement is triple that of 15°C to 25°C.	Though cattle are very resilient, the increased temperatures will likely increase heat stress of the cattle and also increase the amount of water they consume.
Broilers	The recommended temperatures for poultry varies with age. Week 1 - 30°C, week 2 - 26°C, week 3 - 22°C, week 4 - 20°C The ideal relative humidity for poultry is approximately 60%	Increased future temperatures will often exceed these thresholds and animal heat stress may occur.
Eggs	Chickens lay eggs best at temperature of 11°C to 26°C. Below 11°C many chicken types do not lay eggs. Above 28°C production and quality of eggs decrease. Relative humidity of more than 75% will decrease egg production.	Increased future temperatures will often exceed 25°C and therefore production and egg quality will deteriorate unless air conditioners are used. High humidity may occur due to enhanced evaporation on hot days though heat stress is more likely to decrease production.
Timber	uMuziwabantu LM has the largest concentration of forestry activity within the Ugu DM. The Ugu district produces an estimated 195 000 tons of pine per annum as well as 1755 million tons of gum and wattle that is used by a major pulp mill. Ideal regions for commercial plantations is in subtropical parts of South Africa that are above 400 m altitude where the rainfall is in the range 850-1200 mm and the mean annual temperature above 16ºC .	Timber should cope well in the future. Increased CO_2 in the atmosphere will enhance growth of large trunked trees. The increase in temperature will have minimal effect on the tree, though the increased potential of forest fires will damage stocks.

4.3.2.8 Tourism impacts

Focus Area	Potential Risks
Tourism	• Water supply security compromised dissuades tourism • Increased perception may detract from beach going activities. • Changes to ecosystem may impact wildlife and natural beauty. • Potentially more drowning incidents • Beach erosion reduces the appeal to holiday makers. • Outdoor activities will be limited to the warmer seasons. • Extreme weather events can damage tourism infrastructure and have a negative impact on the nature reserves. • Damage to beach and sanitation infrastructure, potential loss of beach Blue Flag status[114].

In order to promote tourism the Ugu South Coast Tourism Entity has strategic objectives in place however they could possibly be impacted by climate change. These objectives include:

- **Growth of the tourism economy by increasing volumes of visitors:** this objective includes plans to market the tourism sector using media. However, changing climates such as increased annual rainfall can deter tourists from coastal and ecotourism destinations as indoor activities become more popular. Beach degradation resulting from sea level rise impacts the tourism potential of coastal destinations and drought can have negative impacts on tourism if water supply is compromised.
- **Host events to increase tourist volumes in Ugu:** The weather affects the number of people attending events for example increased rainfall can reduce the number of people attending outdoor events and droughts have negative impacts on golf courses reducing their attractiveness.
- **Activate coastal management and development projects:** Sea level rise results in inundation of coastal low lying areas, beach erosion and damage to estuaries which can negatively impact tourism. Therefore, coastal management and development projects are important to manage the negative impacts of climate change.
- **Develop tourism products and events that are unique and sustainable**: Ugu has projects in place to develop trail networks and promote the KwaXolo Caves, Ntelezi Msami Heritage Project and Emaweni Big 5. Climate change can negatively impact projects such as these, for example increased annual rainfall makes outdoor activities such as trails less attractive. Droughts can negatively affect nature reserves such as Emaweni by reducing grazing for wildlife.

All outdoor activities will be most directly sensitive to the changing climate. However some activities may benefit from these changes.

Table 18: The main tourism activities include[115]

Activity type	Activity	Climate impact
Maritime Activities	Scuba Diving; Blue Flag beaches and beach activities; Deep sea and rock fishing (Sardine Run). HCM Beach Festival, ski boating, swimming, water sports, whale watching	Increased temperature will likely increase activity desirability and may also extend the duration for which it is opportune. Water sports are less sensitive to extreme temperatures. Increase in rainfall intensity may make activities less popular. Sea-level rise may damage coastal areas and reduce beach areas.
Sport and Adventure Tourism	Oribi Gorge swing; Forest activities: mounting biking, hiking; Sani2C; Easter Adrenalin; Golf Courses (Africa's Golf Coast); SA Women Open (European Ladies Tour); Africa Bike Week;	Increased temperature may increase activity desirability and may also extend the duration for which it is opportune. Though extreme temperature and heat waves may have a

[114]Ugu District Growth and Development Strategy: Final Report (December 2012).

[115] Ugu Municipality District IDP, Annual Review 2015/16, pg. 12, http://ugu.gov.za/Documents/IDP/Ugu-District-Municipality-IDP-2015-16.pdf

	Margate Air Show, Dive sites, White water rafting, canoeing.	detrimental effect. Increase in rainfall intensity may make activities less popular.
Cultural tours and Heritage Sites	Isandludlu/Tragedy Hill: where Shaka's warriors killed a group of Mpondos, Execution Rock: where enemies where executed by Zulus, Kniesel's Castle: 19th Century Dwelling declared a heritage site, Ugu Jazz Festival.	Increased temperature may increase activity desirability and may also extend the duration for which it is opportune. Though extreme temperature and heat waves may have a detrimental effect. Increase in rainfall intensity may make activities less popular.
Agritourism	Touring Farming areas. Fruit picking and panicking, horse-riding	Climate sensitivity of the farming industry may reduce the appeal of Agritourism.
Ecotourism	Nature Reserve and birding, Umtamvuna Nature Reserve, Uvongo Nature Reserve	Warmer days should increase the desire to do ecotourism activities, however, climate impacts to reserves through vegetation patterns no longer meeting the suitability criteria should reduce the desire for ecotourism.
General tourism	Increased variability in climate could have an impact on the ability to be able to take part in the tourism activities all year round. Outdoor activities will be limited to the warmer seasons. Extreme weather events can damage already poorly maintained tourism infrastructure and have a negative impact on the nature reserves. Sewerage spills – caused by flood damage to sanitation infrastructure – has resulted in the loss of Blue Flag status for several beaches[116]. Sea level rise constrains the amount and type of tourism infrastructure development that can happen on the coast and can have an impact on the maritime tourism activities.	

Future Climate changes may however have some positive benefits to the tourism industry, particularly making warm summer peak periods longer and more conducive to outdoor activity. However, the more extreme and variable weather conditions may also give the area a negative perception among tourists. Diversifying potential tourist activities and investing in more resilient infrastructure may serve to negate this changed perception and allow for year round tourist influx.

4.4 External indirect impacts through climate changes

Climate changes are global but will affect direct areas to varying degrees based on exposure, resilience and hazards. However where institutional arrangements exist between locations for resources, funding, trade, or other engagements, on the ground impacts of climate change may be expressed through negotiations in these arrangements.

The Stockholm Environment Institute provides a simple framework that can be used to identify unconsidered external indirect impacts[117]. The framework describes direct impacts and the four pathways (namely people, biophysical, trade and finance) via which climate change impacts are indirectly transferred to a receptor system. The people pathway includes impacts resulting from migration, health and changes in tourism. The biophysical pathway brings about changes through the flow of ecosystem services and resources such as water. Climate change impacts resulting from changes in the flow of capital were brought about by the finance pathway. The trade pathway results in climate change impacts involving price as well as quantity and quality of goods and services.

[116] Ugu District Growth and Development Strategy: Final Report (December 2012).

[117] National Adaptation Plans and the indirect impacts of climate change, The Stockholm Environment Institute, SEI, https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-PB-2014-Indirect-climate-impacts-NAPs.pdf

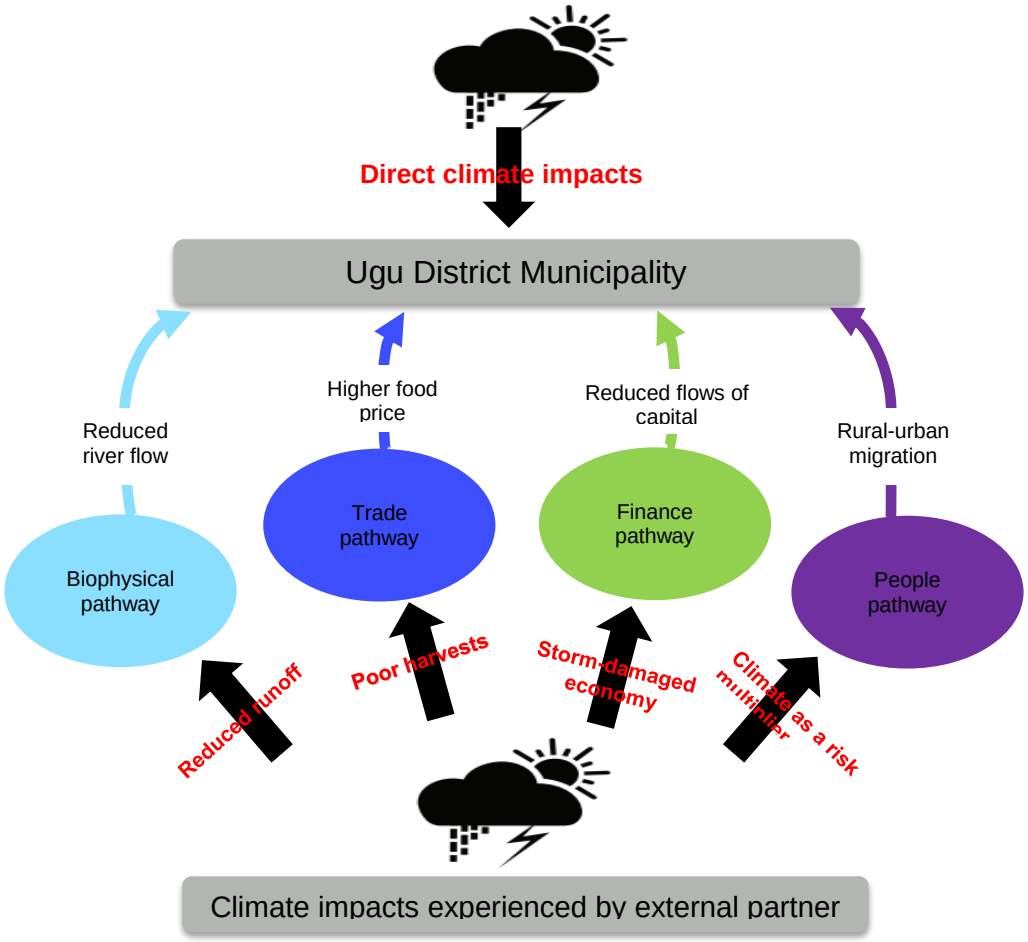


Figure 75: External influences of climate changes

Climate change impacts do not only directly influence decision makers but also indirectly via the situation in external locations. For example, climate change impacting runoff affects the upstream river basin reducing river flow. Bio-physical pathway: reduced river flow impacts downstream resources. Trade pathway: poor harvests impacts food security/prices. Finance pathway: damages in local areas may alter finance priorities, thus negatively impacts businesses in Ugu. People pathway: changes to local communities may change migration trends. Scenario assessment must be cognisant of the dependence areas climate exposure.

5 Climate Change Response Strategy

5.1 Response Options

The response options are targeted at three different levels to ensure that action can be undertaken by all applicable stakeholders.

I. Strategic level: Strategic response presenting sectoral risks and high level actions and direction to be undertaken by decision makers (5.7).

II. Action plan: Action planning is the bridge between the strategic level directional guide and the local level decision support matrix. It comprises project level actions, integrating climate resilience into existing and future developments and larger scale planning campaign objectives (5.10).

III. Decision making support matrix: Presentation of climate risks per local municipality, impacts and consequences, targeted adaptation, and mitigation options for the four variable area/land use types of Urban and Rural areas, Commercial and subsistence agriculture. The implementation options account for both community based and governmental stakeholders (5.11).

5.2 Vision

Establishing a shared and common vision for climate change response is a way for the municipality to integrate response objectives and required principles into the broader vision of the Ugu District Municipality.

The climate change vision is a credible statement of where the District would like to be in future and represents a call to action for the District and its stakeholders. It outlines the municipal response to the challenges presented by climate change, placing a strong emphasis on managing climate change, rather than simply responding passively. It reads as follows:

> ***"A low carbon and climate resilient Ugu committed to sustainable and sustained economic and community development"***

Achieving this vision will demand a shared and common effort by the Ugu DM and relevant stakeholders. To catalyse transformative change toward a more resilient Ugu DM the municipality will promote a set of cross-cutting guiding principles in order to achieve their vision. The key principles as presented below are recognised to support effective climate change response.

- Increase awareness of climate change and its projected impacts;

- Build institutional capacity required to address climate change;
- Integrate relevant climate change information into planning, policies and decision making process;
- Improve the adaptive capacity of human, natural and built systems; and
- Establish or strengthen partnerships that enhances climate change response capacity.

5.3 Key Strategic Objectives

The climate change response objectives have been developed as statement of what the municipality would like to achieve in the medium- to long-term to deal with the climate change risk outlined in previous sections. The Climate Change Response Strategy is strongly aligned with the Ugu DM's development priorities and strategic objectives as outlined in the IDP:

Accordingly, the table below provides a breakdown of the Ugu DM climate change response objectives and their alignment to the Ugu DM's broad Strategic Objectives.

Key Strategic Organisational Objectives

DP 1. To provide access to sustainable quality drinking water and sanitation services;
DP 2.To create a conducive environment for economic growth and job opportunities;
DP 3. To develop and maintain a financially viable and sustainable organization that achieves full compliance with legislation;
DP 4. To build and strengthen the administrative and institutional capability of the municipality;
DP 5. To develop and promote an integrated sustainable environment; and
DP 6. To create a conducive environment for participatory development.

Table 19: Strategic Objectives

Climate Change Objective	DP 1	DP 2	DP 3	DP 4	DP 5	DP6
• Water security and efficiency	X	X	X	X	X	X
• Climate resilient and low carbon development: ○ Infrastructure ○ Transport ○ Settlements	X	X	X	X	X	X
• Energy efficiency and demand side management		X	X	X	X	X
• Biodiversity and ecosystem management		X	X	X	X	x
• Food security (Agriculture)				X	X	X
• Public health	X		X	X	X	X
• Disaster management	X	X	X	X	X	X
• Build response capacity through improved coordination and awareness	X	X	X	X	X	X

5.4 Ugu District Municipality: Climate Change Approach

In alignment with the National Climate Change Response Policy, the Ugu DM Climate Change Response Strategy takes a dual approach to climate change response, encompassing adaptation and mitigation.

- **Adaptation** to climate change refers to adjustments in human and natural systems in response to actual or expected climatic variations, with a view to moderating harm or exploiting beneficial

opportunities[118]. It addresses the reduction of climate vulnerability and enhancement the adaptive capacity in terms of the local communities, economy, ecosystems and infrastructure.

- **Mitigation** refers to efforts to reduce/prevent the emission of greenhouse gases (GHGs) and/or facilitating their removal from the atmosphere. As such the Ugu DM will be contributing to national efforts in reducing GHG and developing a low carbon economy in support of livelihood sustainability.

The purpose of the Strategy is to coordinate climate change response in the Ugu DM and its local municipalities, expediting the development of a low carbon economy and increased climate resilience in alignment with the Ugu DM's strategic objectives.

A key component of the Strategy will be the "mainstreaming" of climate change. The Ugu DM and its local municipalities have a crucial role to play in facilitating climate resilience through the performance of mandated responsibilities. These include human settlement planning, urban development, provision of municipal infrastructure and basic services, water and energy demand management and local disaster management.

Mainstreaming of climate change response implies that local government adopt, expand and enhance the measures that factor climate risk into their normal decision-making and planning processes. Adaptation to climate change will require standalone policies and plans as well as the mainstreaming of response measures into existing activities and functions of local government.

Climate change considerations must be integrated into the everyday functioning of local government and included in development planning tools such as IDPs and SDF's

Adaptation Approach

Various approaches to climate change adaptation exist and can be broadly categorized as follows:

- Modifying threats, e.g. building a dam for flood control;
- Preventing effects and impacts, e.g. introducing drought resistant crops; and/or
- Accepting the loss (when an adaptation measure is too costly).

Generally the distinction is made between adaptation approaches, namely anticipatory or reactive adaptation. Anticipatory adaptation refers to taking action in preparation of climate change. Reactive adaptation refers to taking action when climate change effects are experienced.

Future climate trends remain uncertain, highlighting the need for flexible response and adaptation strategies for the medium and long term. It also follows that adaptation will require greater consideration of local context compared to mitigation strategies.

The Ugu DM's Climate Change Adaptation approach will be guided by the following adaptation specific principles:

1. **Administrative** – Adapt policies and plans to reduce vulnerability to climate change and improve capacity benefit from potential opportunities related to climate change impacts;
2. **Operational** – Introduce technical, structural and economic adjustments to improve climate change resilience;
3. **Regulatory** – Adapt regulations (by-laws), standards, guidelines to include climate change considerations;
4. **Monitoring and Evaluation** – Support relevant research and monitoring of climate change impacts and adaptation measure for evaluation purposes;
5. **Awareness** – Build awareness of climate change and adaptation on all levels; and
6. **Stakeholders** – Establish strategic partnership and work cooperatively across organisational, regional and sectorial boundaries to deliver dynamic and robust adaptation.

The Ugu DM should initially focus on developing actions and building capacity followed by the identification and implementation no-regrets options, prioritizing on low-cost or highly cost-effective interventions that will improve resilience irrespective of climate change impacts.

A cross-cutting consideration throughout the adaptation process will be the avoidance of mal-adaptation. This refers situations where options do not have unintended consequences, impeding adaptation or

[118] IPCC.2007.

exacerbates vulnerability elsewhere and highlights the need for holistic approaches as well as monitoring and evaluation.

Community-based Adaptation

Community-Based Adaptation (CBA) entails response measures primarily aimed at improve the capacity of local communities to respond to climate change risk and impacts. CBA requires an integrated approaches that are cognisant of traditional knowledge and aims to address current vulnerabilities, but also build communities' resilience of people to cope with future challenges. CBA generally emphasises the protection of ecosystems on which people depend on for their livelihoods.

To effectively build adaptive capacity on a community level, Ugu's climate change response incorporates four inter-related strategic priorities:

- Promotion of climate-resilient livelihoods, including income diversification and capacity building for planning and improved risk management;
- Disaster risk reduction to reduce the impact of hazards, particularly on vulnerable households and individuals;
- Capacity development for local civil society and governmental institutions so they can provide better support to communities, households and individuals in their adaptation efforts; and
- Advocacy, social mobilisation and empowerment to address the underlying causes of vulnerability.

Creating an enabling environment for effective CBA will be determined by the prevailing policies, governance structures and decision-making processes and thus the adaptation approach cannot be limited promote change only on a the community level.

Mitigation approach

The Ugu DM's goal is to facilitate the move towards a green, low carbon economy reflecting the National Climate change policy's desired approach to mitigation. In order to archive its mitigation objectives the Ugu DM will be guided by the following mitigation specific principles:

1. **Setting performance benchmarks –** Determine emission baseline against which the collective outcome of all mitigation actions will be measured.
2. **Identify desired mitigation contribution for relevant sectors** – mitigation efforts should be focussed on key sectors with the greatest mitigation potential and supported in the development of emission reduction outcomes.
3. **Mitigation Plans** – Provide direction to public and private sector stakeholders in developing contextually relevant energy plans and programmes that will support emission reduction targets and sustainable energy production;
4. Application **economic instruments** to support desired emission reduction outcomes;
5. **Monitoring and evaluation** of strategic mitigation actions.

Due to the Ugu DM's relatively low carbon footprint mitigation potential is limited compared to more industrialised regions of the country. A mix of economic instruments such as carbon taxes is to vibe implemented on a national level, and the Ugu DM will have to understand the implications in order to facilitate implementation.

5.5 Mainstreaming

Climate change impacts will cut across economic sectors, administrative boundaries and time scales. This requires climate change response to be part the municipality's broader development policy. The

implementation of specific adaptation options may be relevant in certain contexts, however, in the long term a project-based climate change response might to be sustainable or produce the desired results.

Accordingly Ugu's climate change response strategy will have to be supported by an integrated policy approach. This will require a shift in how Ugu deals with policy development, budgeting, implementation and monitoring and evaluation. The UNDP defines three levels of intervention for mainstreaming Climate Change Response[119]:

1. **Strengthening the development base:** Consist of making smart development choices aimed at reducing general vulnerability. Increasing the overall resilience of the population, not just to climate change, strengthens the foundation for climate change adaptation.
2. **Promoting mainstream adaptation measures:** Entails the integration of climate change consideration into government decision-making processes to facilitate the development of climate resilient policies. This involves the policy development and addressing sectoral adaptation requirements.
3. **Specific adaptation measures:** Specific measures aimed at addressing issues missed by the previous two levels.

These three levels of mainstreaming is encapsulated in a proposed framework developed by the UNDP to guide the mainstreaming of climate change response into development planning. The framework consists of three broad components, each of which can be addressed through a variety of actions depending on contextual relevance.

While the components does not have to follow specific sequence, it is recommended that some primary actions will need to be addressed if mainstreaming efforts are to be sustainable and produce the required outcomes. These primary actions are highlighted in red. The green boxes identifies the actions focussing exclusively on climate change and will have to addressed in partnership with climate experts, while the blue boxes identifies mainstreaming activities that will have to be reviewed from a climate change perspective.

[119] UNDP. Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners. http://www.cakex.org/sites/default/files/Guide%20Mainstreaming%20Climate%20Change%20Adaptation%202011.pdf

Figure 76 A programmatic Approach to Mainstreaming Climate Change Adaptation

The sequencing and combination of actions outline in the proposed framework will context specific, but the structure serves a frame of reference for this strategy. Since national and local climate change response efforts and mainstreaming are still in its infancy, the Ugu District's strategic approach to climate change will have to be tested as experience increases and new information becomes available. The document should thus be regarding as a live document which will require continual review and improvement. The figure below

5.6 Sectoral Climate Change Response Recommendations

Adaptation and mitigation should not be implemented in isolation from existing regulatory frameworks, management structures and processes in decision-making relevant to the fulfilment of the Ugu DM's municipal mandate.

The mainstreaming of climate change response into existing frameworks will ensure more efficient use of resources in the Ugu DM and local municipalities as well as the interactions between climate change response and development.

Subsequently the mainstreaming of climate change response into sectoral budgets will be essential. This will prove more effective in terms of facilitating effective climate change response and realising no-regrets interventions, rather than necessitating additional dedicated climate change budgets in an already resource scarce municipal context.

The mainstreaming of climate change into all municipal sectors will allow for the gradual implementation of climate change response measures within existing budgets balancing incremental costs with the economic, environmental and social values produced. High level governance related response options include:

- Address procurement to ensure it support efficient resource use and that tender specs, particularly for large infrastructure projects, incorporate the wide range of future climatic conditions
- Consider best institutional location of climate change issues, and incorporate climate change within agendas of all structures, from Council to management and operations; and
- Budget allocations must ensure that spending supports development of new infrastructure development AND maintenance of existing infrastructure.

Given the current politics of climate change adaptation and the extent to which it is on the agenda, a useful approach may not be to focus on climate change per se but rather on improving preparedness, robustness of decision making and overall resilience. Risk management approaches along with economic analysis will help to target specific strategies to the most urgent, cheapest or highest net-benefit activities[120].

The following section provides an overview of local municipality risk profiles against particular climate changes in each of the priority sectors as well as expanded mainstreaming opportunities and entry points on a sectoral basis.[121]

[120] Climate ADAPT. 2015. Adaptation Support Tool.
[121] GIZ. 2012. Let's Respond Toolkit

5.7 Strategic response options and municipality risk profile

The following section provides an overview of local municipality risk profiles against particular climate changes in each of the priority sectors identified in Section 4. This is followed by a more detailed discussion of relevant sectors, response options and the structure through which they can be integrated.[122]

▪ Energy

Energy	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	**Energy Supply and Electricity Service delivery** • Work to ensure low income housing is thermally efficient (put in ceilings); • Solar water heater roll-out programmes; • Implement efficient appliance programmes (e.g. fridges, kettles, lights) • Smart metering of top electricity consumers for better electricity management • Green procurement to ensure all municipal pumps, motors, lighting is efficient • Retrofit of municipal/public lighting and buildings **Regulations / Incentives** • Solar water heater by-law for all new buildings requiring minimum thresholds for water heating requirements from a renewable energy sources; • Implement thermally efficient housing delivery, e.g. legislate the provision of ceilings in government-delivered housing (ceilings a warmer house in winter; cooler in summer);
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	

[122] GIZ. 2012. Let's Respond Toolkit

Increased heat wave incidence	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	• Building regulation to ensure efficiency in all new buildings, e.g. require energy efficiency plans for building/development plan approval; • Provide incentives for energy efficiency when supplying new connections; • Use air management approval processes to leverage efficiencies; **Awareness** • Focused awareness campaigns on energy use; • Commercial and/or industrial energy forums that provide information and learning exchange on energy efficiency within the sectors.
	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

5.7.1 Municipal Infrastructure

Municipal Infrastructure	**Ezingoleni**		**Hibiscus Coast**		**uMdoni**		**uMuziwabantu**		**Umzumbe**		**Vulamehlo**		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Map vulnerable areas (flood lines, etc.) and implement development bans in highly vulnerable zones; • Relocate existing development from areas of high risk; • Strengthen building code requirements according to increased risks of flooding, heat waves, intense storms on building and infrastructure development projects; • Maintain and update drainage systems; • Consider permeable pavements, green roofs and rain tanks to increase on-site retention of storm water;
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	

Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	• Road maintenance and storm water drainage maintenance and upgrade plans to cope with increased volumes and storm damage and deterioration of road surfaces; • Effective transport planning and management: o Roll out of bus rapid transport and school bus systems o Allocate road space to public transport vehicles o Support walking and cycling modes, e.g. cycle lanes, etc. • Increase government vehicle fleet efficiency.
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

5.7.2 Water Resources

Water	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Improve monitoring and forecasting systems for floods and droughts – develop links with water research institutes to ensure early preparation for drought or flood years; • Preservation of wetlands for current and future flood risk; • Water flow monitoring towards improved infrastructure planning and development; • Water tariff structures; • Water restrictions: prepare plans to balance the needs of competing users when water availability is reduced (drought years, peak seasons) • Pressure management; • Awareness and Education campaigns for water conservation; • Encourage use of water conservation
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	

Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	technologies such as low flush toilets and low flow showerheads; • Changes in agricultural management practices in line with water scarcity (e.g. changes in crop types, dry land farming); • Planning approval to consider current and future water availability; • Improve sanitation to curb disease spread; • Rainwater harvesting for uses such as toilet flushing, car washing, irrigation • Re-use of grey water or water from sewage treatment • Control of invasive alien vegetation • Reduction of leaks • Response options for peak supply in drought years need further investigation (from cost • Benefit perspective and development approach): increased storage capacity/widening of dams, • Trucking of water, desalination, development approvals, etc.
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	

5.7.3 Terrestrial Biodiversity

Terrestrial Biodiversity	**Ezingoleni**		**Hibiscus Coast**		**uMdoni**		**uMuziwabantu**		**Umzumbe**		**Vulamehlo**		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Vulnerability mapping and related management plans, • Protect and increase existing ecosystems services buffering against climate change
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	

Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	impacts; o wetlands o river courses o land care/erosion prevention o water sheds • Monitor and control alien plants and pests; • Monitor sustainability biomass used for energy; • Improve buffers (ground coverage) to protect against increased runoff from more intense storms
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Decreased number of cold nights	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	
	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	

5.7.4 Disaster Management

Disaster Management	**Ezingoleni**		**Hibiscus Coast**		**uMdoni**		**uMuziwabantu**		**Umzumbe**		**Vulamehlo**		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	• Install Early Warning Systems and develop links with key scientific and sector institutions to improve predictive ability • Increase institutional capacity (predictive skills, plans, training and equipment) • Develop drought response plans and capacities; • Have robust disaster management plans in place, particularly for vulnerable areas; • Encourage local voluntary action for
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	

Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	disaster management; • Changes zoning and building standards to reduce disaster risk; • Increasing rates of rural-urban migration which may result in the expansion of unregulated settlements in hazard-prone areas and municipalities must be responsive to these new risk areas; and • Explore strategic partnerships with insurance industry.
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	

5.7.5 Agriculture

Agriculture	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Agricultural Development planning addressing the resilience of commercial and subsistence farming activities in the district should have the following considerations: • More frequent crop failure from more droughts; • Decreased chill unit accumulation from fewer cold days; • Less soil moisture due to declining precipitation and greater evaporation rates;
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	
	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	

Increased temperatures	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	• Increased incidence of pests due to higher mean temperature or reduced production of key crops from pests and disease; • Reduced water security; and • Adaptive and mal-adaptive agricultural practices; • Exploitation and overexploitation of groundwater resources; • Changes in crop types or switching to dry land farming
	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	
Increased heat wave incidence	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	
Decreased number of cold nights	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	
	Moderate risk	Moderate risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Insignificant Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	

5.7.6 Tourism

Tourism	Ezingoleni		Hibiscus Coast		uMdoni		uMuziwabantu		Umzumbe		Vulamehlo		
Climate change impacts	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	**Strategic response**
	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	Commercial	Substance	
Increase annual rainfall	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Minimal Risk	• Build climate resilience and adaptive capacity of tourist attractions/destinations and encourage green tourism infrastructure investment. • Encourage tourists to participate in the protection and conservation of natural environment, i.e. "Eco-tourism". • Promote research, capacity building and awareness in the tourism sector.
	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Minimal Risk	Minimal Risk	Minimal Risk	Moderate risk	
Increased rainfall intensity in summer	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Moderate risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	
Seasonal rainfall shifts	Major risk	Major risk	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	

	Major risk	Major risk	Minimal Risk	Minimal Risk	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	• Coordinate an outreach program of workshops for tourism business across the district to accelerate the communication of climate change issues to industry. • Support the establishment of energy efficiency programmes and the introduction of renewable energy into the tourism sector. • Establish programmes that will allow tourists to offset the emissions generated through their travel to and in South Africa.
Drought potential	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Major risk	
	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	
Increased extreme temperature days	Major risk	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Catastrophic Risk	Major risk	Major risk	Moderate risk	
	Moderate risk	Major risk	Moderate risk	Major risk	Major risk	Major risk	Major risk	Major risk	Major risk	Catastrophic Risk	Moderate risk	Major risk	

5.8 Strategic response options: Priority sectors

5.8.1.1 Energy Sector

The energy sector is primarily guided by national policies, but on a local level the UGU DM should consider the following:

- Promoting energy efficiency or managing demand for increased energy;
- Promoting adoption of renewable energy sources;
- Introduce of cleaner fuels such as natural gas into the current fossil fuel mix where feasible;
- Increased use of renewable energy.
- Integrate efficient resource use into a requirement/component of economic development;
- Aim for all households to have access to safe, affordable and reliable energy sources.

Municipal Functions

Schedule 4B of the Constitution of South Africa (1996) assigns municipalities the responsibility for electricity. As part of their Environmental Management Plan, municipalities may also specify their plans for reducing their reliance on fossil fuels, increasing renewable energy usage and minimizing electricity consumption.

Regulatory Framework

The National Energy Act (Act 34 of 2008), which seeks to ensure that South Africa has access to a diverse range of energy resources which are sustainable and affordable, provides the overarching legal framework for the energy sector.

A number of national sector departments may play a role in supporting municipalities with respect to energy. These include the Department of Energy, the Department of Economic Development, the Department of Environmental Affairs, the Department of Cooperative Governance and the Department of Trade and Industry amongst others. Relevant provincial departments also play a key role and the National Energy Regulator of South Africa is also an important player in this sector.

Response Options

Energy Supply and Electricity Service delivery

- Pursue 100% electrification, including in informal areas;
- Explore renewable energy development and procurement through PPAs;
- Explore free basic alternative energy sources for poor non-electrified households;
- Work to ensure low income housing is thermally efficient (put in ceilings);
- Solar water heater roll-out programmes;
- Implement efficient appliance programmes (e.g. fridges, kettles, lights)
- Smart metering of top electricity consumers for better electricity management
- Green procurement to ensure all municipal pumps, motors, lighting is efficient
- Retrofit of municipal/public lighting and buildings
- Greenhouse gas emissions data capture and reporting
- Monitor and record local air quality on a continuous basis

Regulations / Incentives

- Solar water heater by-law for all new buildings requiring minimum thresholds for water heating requirements from a renewable energy sources;
- Implement thermally efficient housing delivery, e.g. legislate the provision of ceilings in government-delivered housing (ceilings a warmer house in winter; cooler in summer);
- Building regulation to ensure efficiency in all new buildings, e.g. require energy efficiency plans for building/development plan approval;
- Provide incentives for energy efficiency when supplying new connections;
- Use air management approval processes to leverage efficiencies;

Awareness

- Focused awareness campaigns on energy use;

Commercial and/or industrial energy forums that provide information and learning exchange on energy efficiency within the sectors.

5.8.1.2 Municipal Infrastructure

Spatial Development

SDF's provide key entry points for addressing pressing climate change related issues and climate change responsive spatial development planning will be critical to the long terms sustainability of the UGU DM. Apart from support climate resilient development, failure to take climate change impacts into account could deem municipalities liable for damage and losses resulting from negligent planning decisions.

The municipal SDF should consider climate change impacts on the following areas:

- Sensitive, vulnerable, highly dynamic and stressed ecosystems in the municipal area
- Vulnerable neighbourhoods;
- Desertification;
- Soil loss;
- Ecologically sensitive areas;
- Drought vulnerable areas;
- Flood risk areas or low-lying areas;
- Impact of deforestation and the land use changes that may result from climate change and migration;

Municipal Functions

The development of an SDF is a requirement for all municipalities as part of the 5 year IDP. The role of the SDF as the basis of land-use and development planning makes them very significant in the UGU DM's climate change response.

Regulatory Framework

The National Spatial Development Perspective (2006) Department of Rural Development and Land Reform's draft SDF guidelines provides are the primary guiding documents for spatial development planning. The National Department of Rural Development and Land Reform, as well as the Department of Cooperative Governance and the provincial equivalent departments are the main departments regulating and supporting municipalities for this function.

Response Options

- Map vulnerable areas (flood lines, etc.) and implement development bans in highly vulnerable zones;
- Implement land use planning and zoning to avoid building and development infrastructure in hazard prone areas;
- Relocate existing development from areas of high risk;
- Strengthen building code requirements according to increased risks of flooding, heat waves, intense storms on building and infrastructure development projects;
- Maintain and update drainage systems;
- Consider permeable pavements, green roofs and rain tanks to increase on-site retention of storm water;
- Building regulation to ensure efficiency in all new buildings – monitor and enforce and encourage best practice development;
- Densification of land use through zoning regulations to support high density living and work and mixed use;
- Development preference given to developments on priority nodes;
- Ensure thorough planning reduces incidence of unplanned population and economic growth and ensure contingency for unplanned settlements/growth;
- "Smart growth" planning—a strategy that highlights high-density, mixed-use, transit-oriented development— also has other goals, such as maintaining open space, farmlands, and other

natural areas and directing city resources toward existing communities rather than diverting them to new development in outlying areas.

5.8.1.3 Transport

Polokwane is one of the cities earmarked by the National Department of Transport for the Integrated Rapid Transport initiative and required to prepare an Integrated Transport Plan. Apart from efficient transport systems the UGU DM will also be required consider relevant climate change impacts into the maintenance management and development planning of the districts road infrastructure.

Municipal Functions

Schedule 4B of the Constitution of South Africa (1996) assigns municipalities the responsibility for municipal public transport, as well as roads.

Regulatory Framework

The National Land Transport Act (Act 5 of 2009), provides the overarching legal framework for land transportation in South Africa.

A number of national sector departments may play a role in supporting municipalities with respect to transport. These include the Department of Transport, the Department of Environmental Affairs, the Department of Economic Development, the Department of Tourism, the Department of Cooperative Governance and the Department of Trade and Industry amongst others. Relevant provincial departments further support municipalities, while the South African National Roads Agency Limited (SANRAL) and the National Roads Agency also play a key role.

Response Options

- Road maintenance and storm water drainage maintenance and upgrade plans to cope with increased volumes and storm damage and deterioration of road surfaces;
- Effective transport planning and management:
    - Roll out of bus rapid transport and school bus systems
    - Allocate road space to public transport vehicles
    - Support walking and cycling modes, e.g. cycle lanes, etc.
- Increase government vehicle fleet efficiency.

5.8.1.4 Water Resources

Extreme weather events and changing rainfall patterns will require the UGU DM to and local municipalities will need to reassess water resources management and supply, storm water management and water quality. In order to mainstream climate change response into the water sector the municipal water services development plans will consider:

- Integrate climate change projections into analysis of future water availability;
- The increased frequency of intensified rainfall events will require the consideration of potential damage to storm water infrastructure, and require adaptive maintenance management and design parameters for new developments;
- Population growth and economic development will alter the demands placed on water supplies and put pressure on the UGU DM in terms of maintaining water security;
- Industrial, domestic and agricultural users are highly dependent on a reliable supply of water. A reduction in rainfall amount or variability, or an increase in evaporation would further strain the already limited amount of water resources and water quality across the UGU DM;
- All water infrastructure capacities will need to be improved to cope with the potential for increased damage due to higher frequency of extreme weather events;
- Improving the monitoring and forecasting of flooding through an integrated early warning system will prove more cost effective than carrying the costs of damage;
- Design water infrastructure to be storm and flood resilient;
- Rehabilitate natural flood barriers such as river beds;
- On top of the current water conservation programmes, the UGU DM needs to consider demand management in light of potential drought frequencies which will require balancing the competing needs of consumers.

Municipal Functions

District Municipality and Polokwane Local Municipality are Water Services Authorities (WSA) while the other four local municipalities within the District are serving as Water Services Providers (WSP). The responsibility to provide clean and safe drinking water rests with the UGU DM as the WSA.

Schedule 4B of the Constitution of South Africa (1996) assigns municipalities the responsibility for water and sanitation services. Municipalities that are WSAs take overall responsibility for the regulation of this service in their area of authority.

Regulatory Framework

The Water Act (Act 36 of 1998) provides the overarching legal framework for water services in South Africa.

A number of national sector departments may play a role in supporting municipalities with respect to water and sanitation with relevant provincial departments also playing a key role. These include the:

- Department of Human Settlements;
- Department of Water and Environmental Affairs;
- Department of Cooperative Governance.

Response options

- Improve monitoring and forecasting systems for floods and droughts – develop links with water research institutes to ensure early preparation for drought or flood years;
- Preservation of wetlands for current and future flood risk;
- Water flow monitoring towards improved infrastructure planning and development;
- Water tariff structures;
- Water restrictions: prepare plans to balance the needs of competing users when water availability is reduced (drought years, peak seasons)
- Pressure management;
- Awareness and Education campaigns for water conservation;
- Encourage use of water conservation technologies such as low flush toilets and low flow showerheads;
- Changes in agricultural management practices in line with water scarcity (e.g. changes in crop types, dry land farming);
- Planning approval to consider current and future water availability;
- Improve sanitation to curb disease spread;
- Rainwater harvesting for uses such as toilet flushing, car washing, irrigation
- Re-use of grey water or water from sewage treatment
- Control of invasive alien vegetation
- Reduction of leaks
- Response options for peak supply in drought years need further investigation (from cost
- benefit perspective and development approach): increased storage capacity/widening of dams,
- trucking of water, desalination, development approvals, etc.

5.8.1.5 Terrestrial Biodiversity

In the UGU DM alien plant species In the UGU DM alien plant species poses a significant threat to the regions natural biodiversity and water resources. Projected climate change may result in the further spread of destructive alien species, increasing the risk posed to the indigenous plant life and threatening water resources.

Apart from threatening indigenous biodiversity and water resources, alien species will also negatively affect climate change resilience by increasing the risk of veld fires and reducing the traditional ecosystem services.

Municipal environmental programmes within the UGU DM should addressed the following:

- Fire risk reduction;
- Identification and conservation of critical biodiversity areas;
- Eradication of alien plants and pests;
- Protect and conserve watersheds;
- Rehabilitate river banks.

Municipal Function

Schedule 4 and 5 of the Constitution outlines several 'functional areas' of government which relate to elements of the environment and its management, including air pollution, beaches and amusement facilities, water and sanitation, and environmental health amongst many others, for which municipalities are assigned responsibility

Regulatory Framework

The National Environmental Management Act (NEMA), Act 107 of 1998, provides the legal framework for environmental management in South Africa. The National Department of Environmental Affairs and the provincial equivalent departments are the primary sector departments regulating and supporting municipalities for this function.

Response Options

- Vulnerability mapping and related management plans,
- Protect and increase existing ecosystems services buffering against climate change impacts;
    - wetlands
    - river courses
    - land care/erosion prevention
    - water sheds
- Monitor and control alien plants and pests;
- Monitor sustainability biomass used for energy;
- Improve buffers (ground coverage) to protect against increased runoff from more intense storms; and
- Capture and reporting GHG emissions data.

5.8.1.6 Disaster Management

With climate change contributing to an increase in disaster risk, disaster management becomes a vital and urgent component of any climate change adaptation program. As part of climate change adaptation measures, the UGU DM needs to focus on risk reduction measures to mitigate natural hazards exacerbated by climate change.

The reduction of current and future vulnerabilities to climate change risk should build on and expand existing disaster management efforts.

Municipal Function

As part of the five year Integrated Development Plan, all municipalities are expected to develop a Disaster Management Plan.

Regulatory Framework

The National Disaster Management Act (Act 57 of 2002) provides the overarching legal framework for disaster management in South Africa.

Response Options

- Install Early Warning Systems and develop links with key scientific and sector institutions to improve predictive ability

- Increase institutional capacity (predictive skills, plans, training and equipment)
- Develop drought response plans and capacities;
- Have robust disaster management plans in place, particularly for vulnerable areas;
- Encourage local voluntary action for disaster management;
- Changes zoning and building standards to reduce disaster risk;
- Increasing rates of rural-urban migration which may result in the expansion of unregulated settlements in hazard-prone areas and municipalities must be responsive to these new risk areas; and
- Explore strategic partnerships with insurance industry.

5.8.1.7 Agriculture

The potential impact of climate change on food production, agricultural livelihoods and food security are some of the biggest concerns in the district as the sector is a key component of the local economy. Due to the importance of agriculture for the UGU DM is warrants being addressed with special emphasis and it is recommended that the UGU DM invest in a dedicated Agricultural Development planning addressing the resilience of commercial and subsistence farming activities in the district.

This plan should address the following considerations:

- More frequent crop failure from more droughts;
- Decreased chill unit accumulation from fewer cold days;
- Less soil moisture due to declining precipitation and greater evaporation rates;
- Increased incidence of pests due to higher mean temperature or reduced production of key crops from pests and disease;
- Reduced water security; and
- Adaptive and mal-adaptive agricultural practices;
- Exploitation and overexploitation of groundwater resources;
- Changes in crop types or switching to dry land farming

Municipal Functions

Municipalities mainly engage in agricultural issues as part of their sector plan development, e.g. LED Strategy, Water Services Development Plan and Environmental Management Plan, where relevant and necessary.

5.8.2 Expanded strategic response options: remaining sectors

5.8.2.1 Waste Management

Municipal Function

Local government is primarily responsible for the collection and the disposal of domestic waste. Municipalities also regulate waste management through the drafting and enforcement of by-laws.

Municipalities are legally required to develop Integrated Waste Management Plans (IWMPs), which provide strategic direction for waste management in municipalities and identifies the resources needed to achieve their goals.

Regulatory framework

The National Waste Act (Act 59 of 2008), provides the overarching legal framework for waste management in South Africa. It is supported by the National Waste Management Strategy of 2010 presents a long-term plan for the sector and stipulates the goals and objectives of the country with respect to waste management. It also identifies roles and responsibilities for various stakeholders in achieving this vision.

Response Options

- Reduction, re-use and recycling of waste;
- Demand Side Management (DSM) activities and waste recycling to reduce landfill related methane emissions;

- Correct disposal waste to improve emissions.

5.8.2.2 Local Economic Development

Agriculture is arguably the economic sector most vulnerable to the impacts of climate change, while the tourism and health sector will also be affected by projected temperature increases, altered rainfall patterns and more frequent extreme events. The impacts of the implementation of carbon taxes to promote a green economy will have to be properly investigate to prevent it from dissuading investment in the district and inhibiting economic development.

Poverty is an important determinant of vulnerability to climate change. Lower-income groups are hit hardest by the combination of greater exposure to climate hazards (e.g. those living in makeshift housing on unsafe and/or remote sites), less capacity to cope and adapt (e.g. lack of assets and insurance), less state provision to help them cope and less legal protection. There are strong complementarities between reducing poverty and reducing vulnerability – in part because poverty reduction involves better provision of infrastructure and services, and because higher incomes increase the adaptive capacity of households

From a Local Economic Development perspective the UGU DM will need to consider the following climate change related issues:

- The sensitivity of economic development plans to climate change. Income flows for rural farmers may be unpredictable, leaving them less able to prepare and cope with climate-related disasters. Agricultural processing, retail trade, local transport, domestic services, tourism, and equipment repairs are all examples of non-farm livelihood activities that can diversify income, allowing people to protect themselves against adverse shocks and trends;
- Industrial and commercial energy efficiency or demand side management mechanisms;
- Relocation of buildings located in hazard-prone areas ;
- Day-to-day operations that rely on steady water supplies may need to be redesigned as climate change constrains water availability;
- Supply chains reliant on climate-sensitive geographic areas may have to be diversified; and
- Climate risks may translate into less disposable incomes, while associated health risks may affect the productivity of the workforce.

Municipal Functions

The Constitution of South Africa (1996); the Local Government White Paper (2006); the Municipal Systems Act (2000) and the Municipal Structures Act (1998) assign municipalities a host of responsibilities tasking them with creating an enabling environment for local economic development. Through the provision of basic services and infrastructure municipalities promote local growth and development.

Response Options

- Assessment of vulnerable livelihoods and sectors dependent on natural resources or carbon intensive sectors;
- Ongoing research and monitoring of climate change impact on vulnerable livelihoods, especially agriculture and tourism;
- Diversification of livelihood strategies (notably non-farm activities to cushion farming based livelihoods);
- Reduce dependence on increasingly costly energy sources – improve efficiency across all sectors;
- Changes in crop types, dry land farming to diversify agricultural activities;
- Attract low carbon or ‘green’ economic activities, including renewable energy opportunities;
- Show visible commitment to sustainable tourism;
- Consider tourism alternatives where impacts interfere with existing tourism bases;
- Implement recycling to increase landfill life-span and provide jobs;
- Invest in public transport to increase mobility and improve access to livelihoods; and
- Work with the community on community-based adaptation projects.

5.8.2.3 Health

Climate change has the potential of increasing the disease burden on the healthcare systems and will result in additional hospital admissions, compromised nutritional status, absenteeism from work and school days, higher incidence of respiratory and heat-related illnesses and premature deaths.

There are several important vector-borne diseases of humans and livestock which respond to climatic conditions. Of particular significance for the UGU DM is the expected spread of malaria into areas which are currently malaria-free due to temperature increases.

Municipal Functions

Schedule 4B of the Constitution of South Africa (1996) assign municipalities the municipal health services function.

Regulatory Framework

The National Health Act (Act 61 of 2003) provides the overarching legal framework for the health sector.

Response Options

- Improved sanitation to curb disease;
- Increased awareness on/preparedness for climate related health threats (vector-borne diseases, heat, air pollution, floods);
- Monitoring of malaria distribution;
- Interventions to reduce air pollution
- Increase staffing and supplies (capacity support) for health facilities
- Nutrition programmes where climate impacts affect livelihoods and food security.

5.9 Instruments for Mainstreaming

There are a variety of existing instruments and mechanisms through which the local government can initiate their climate change response and begin to integrate mitigation and adaptation into their operational processes and channel resources. These instruments can be sector specific or cross-cutting are outlined below.

Instrument/ Mechanism	Details
Integrated Environmental Programme/Plan	The integrated Environmental Programme should identify communities and ecosystems that are vulnerable to climate change impacts. Climate change can potentially increase spread of invasive alien species, while their presence has the potential to reduces climate change resilience and exacerbate climate change impacts. Thus, the Integrated Environmental Programme should consider climate change risk and address on the following: • Reducing wildfires; • Ecosystem protection; • Alien species management and pest control; • Watershed protection and conservation; • River bank rehabilitation; and • Greening initiatives.
Coastal Management	The Coastal Management Plan should include the following: • Mapping of vulnerable coasts;

Instrument/ Mechanism	Details
Programme/Plan	• Developing plans for shoreline management; • Developing strict set-back lines and prohibiting development in areas at risk of flooding; and • Increasing shoreline buffers.
Air Quality Management Plan	Air quality is affected by nitrogen oxides, sulphur oxides, volatile organic compounds and particulate matter therefore the Air Quality Management Plan should highlight the path to reduced emissions. This can be done by pursuing cleaner fuels and having regular vehicle inspections and maintenance in order to decrease transportation emissions. The plan should also enforce emissions licensing in order to achieve low carbon development that aligns with national GHG emissions registry and international GHG emission protocols. Emissions can be monitored by establishing an emissions data bank. Air quality management can also be improved through the development of an education and communication strategy.
Spatial Development Framework	The Spatial Development Framework plays an important role in climate responsive spatial development which can reduce per capita levels of GHGs by increasing efficiencies of transport and the built environment. The framework should consider how climate change impacts ecosystems and ecologically sensitive areas as well as areas affected by land use changes, droughts, floods and desertification. The framework should also promote the smart growth of areas in order to be high-density, mixed-use and transport-oriented.
Local Economic Development Framework and/or SMME Sector Development Plan	Carbon tax and carbon trade barriers make carbon intensive industries less viable therefore new ways of developing the economy should be supported to reduce vulnerability to climate change. An LED framework and SMME plan should promote energy efficiency and demand side management. It should also create environments in which sectors such as timber, trade, transport, tourism and domestic services can thrive and diversify people's incomes so that they are not impacted by climate change as badly. Redesigning supply chains and day-to-day operations that rely on climate-sensitive areas and water may become necessary as climate change impacts water supply.
Agricultural Development Plan	The agricultural sector contributes largely to the national economy and thus climate change impacts in the agricultural sector can negatively affect food security. For this reason the Agricultural Development Plan should reflect on issues such as crop failure, droughts, reduced soil moisture, pests and fires. The plan should also elaborate on agricultural management practices.
Local Tourism Plan	The Local Tourism Plan should promote ecotourism that is energy, waste and water efficient by implementing renewable energy and partnering with organisations and hosting special events which promote the environment.

Instrument/ Mechanism	Details
Water Services Development Plan	The Water Services Development Plan should: • Develop contingency plans for drinking water supplies; • Assess infrastructure in order to minimise the impacts of climate change on leakages, storage capacity, storm water and sewerage infrastructure as well as infrastructure capacity. Design climate resilient infrastructure and make use of green roofs and permeable paving for example; • Water resource projections to determine if climate change and population growth will make it necessary to fine additional water sources; • Implement a water conservation programme which includes balancing the needs of different water users such as the domestic, industrial and agricultural sectors; • Introduce early warning systems and improve monitoring systems; and • Prevent saltwater intrusion and rehabilitate natural barriers.
Energy Master Plan	The Energy Master Plan should emphasise demand management and energy efficiency by introducing affordable cleaner fuels and renewable energy as well as promoting efficient resources use.
Integrated Waste Management Plan	An Integrated Waste Management Plan should promote waste reduction, re-use and recycling as well as demand side management. To reduce emissions waste should be disposed of correctly and methane should be captured from landfill sites depending on practical and financial viability
Integrated Transport Plan	An Integrated Transport Plan should include plans for efficient public transport. Private vehicle users should be encouraged to use public transport or bicycle/pedestrian transport through congestion charges or be encouraged to use unleaded fuel. The need for transport is reduced through compact city planning.
Sustainable Human Settlement Plan	Areas being highly impacted by climate change should be avoided when planning new housing projects. The plan should enforce energy efficient regulations and encourage the use of safe energy sources. Early warning systems should also be activated in communities.
Community Services Plan	A Community Service Plan should support communities and households in reducing their vulnerability as well as reducing GHG emissions. The plan should also increase the available information on experiences and lessons learned in communities regarding climate change in order to inform adaptation policies and

Instrument/ Mechanism	Details
	programmes and inform future actions. Actions that can be taken up by communities and individuals should be publicised.
Poverty Alleviation Plan/Growth and Development Plan	The plan should include strategies to diversify livelihoods, improve food security and provide basic services. Disaster risk reduction measures (such as improved infrastructure) should be implemented in informal and rural settlements.
	Disaster Management Plan Disaster Management Plans should consider the following: • Determine how projected climate change will alter the disaster risk profile; • The feasibility of changing zoning and building standards to prevent damage to infrastructure and buildings during disasters; • It should ensure that there are resources available to cover the costs of emergency planning and services which are becoming more expensive due to climate change; • Encourage the establishment of early warning systems; • Assist municipalities in becoming responsive to high risk areas such as unregulated settlements which arose due to rural-urban migration; • Increase emergency response capacity and designate a community liaison to work on developing settlements that are more resilient to disasters; and • Encourage use of insurance.
Health Policy	A Heath Policy should include interventions which could reduce air pollution as well as a pollution warning system and a heat alert system to warn of heat stress. It should prescribe support for health facilities as well as emergency response.

5.10 Project Action Planning

Directive	UGU DM is mandated under the Constitution of the Republic of South Africa (1996) Section 24 (a) to guarantee everyone an environment that is not harmful to his or her health or well-being. The subsequent clause advocates for sustainable development in which social and economic development is pursued for the present generation without compromising opportunities for future generation. Further the National Development Plan states that a climate change response is imperative to strengthening the nations' resilience and requires the identifying and putting into effect appropriate policies and measures to be climate adaptive. The UGU DM has recognized the crucial role it plays in responding to climate changes by building resilience and adaptive capacity, particularly with regard to human settlement and urban development planning in the short, mid and long term. In order to suitably address the challenges posed by climate change in UGU DM, the study of the likely changes to the climate to be experienced, the assessment of the risks and vulnerabilities in each sectors and the development of a robust, no-regrets strategy must be undertaken. In doing so UGU DM seeks to fulfil its objectives of sustainable and equitable service provision, enabling socio-economic development and providing a safe and healthy environment for all.						
Resources	The UGU DM CCRS serves to guide the UGU DM's strategic approach to climate change response. It will use existing government budgets and new sources of financing by aligning programs along the national framework strategies and actions for climate change.						
Vision	"Build low carbon and climate resilient Ugu committed to sustainable and equitable economic and community development"						
Strategic Objectives	Water security and efficiency	Climate resilient and low carbon development	Energy efficiency and demand side management	Biodiversity and ecosystem management	Food security (Agriculture)	Human Security: Public Health and Disaster Management	Build response capacity through improved coordination and awareness

5.10.1 Water Security

Strategic Focus Area 1	Improved institutional capacity for Climate Change Response in the Water Sector.

Objective 1.1		Supportive policy context for the integration climate change response and water resource management.				
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**		**To be determined by UGU DM**

					Mainstreaming Opportunity in IDP	Time Horizon for Implementation: S – Short M – Medium L – Long Term	Priority: L –Low M – Medium H - High
Institutional	A municipal policy on coordinated water resource management aligning institutional structures and policies.	Review existing water resource management structures, institutional capacity and policies for improved alignment and coordination. Develop policy guidelines for water conservation, allocation, and reuse. Develop and implement municipal guidelines for the rainwater harvesting, for communities and industry.	UGU DM	CAPEX: R 250 000	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Review/Compile water by-laws	Review/compile by-laws Endorse enforcement structures.	UGU DM, DWS, WMA's	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Review mandate of the District Water Forum to include Climate Change Response	Mandate ratified and climate change resilience included as a key priority for the district's water sector.	UGU DM, DWS, WMA's	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Develop a database and information management systems for municipal water resources and users		UGU DM, DWS	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Establish partnership with University of KwaZulu Natal for targeted research and dissemination of results		UGU DM, Local Municipalities, University of KwaZulu Natal	OPEX	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development)		

	Build municipal capacity through targeted training of key municipal officials and staff.	Bursaries, Training Courses, Workshops	UGU DM, DWS, Local Municipalities	CAPEX; R 20 000 per person per annum	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development) **Priority 4:** Education and Skills development (Skills Development, Education) *MTID 14: Knowledge Management*		

Objective 1.2	Implementation and enforcement of regulatory framework.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Review the capacity of relevant statutory bodies to implement and enforce regulations relating to water quality and effluent discharge within the UGU DM's area of responsibility	Review and put forward recommendations for capacity building where relevant.	UGU DM, DWS, DPMES	CAPEX: R 400 000	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment	S, M	
	Supply of low cost field testing kits in rural areas to monitor water quality and improve early warning	https://www.ru.ac.za/latestnews/2013/rhodesr5waterkitforeasytests.html	UGU DM, DWS	R 5 per test	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment *CCI 2: Water Quality Monitoring*	S, M	

	Incorporate climate change considerations into planning and development of water supply infrastructure.	Refer to Guidelines for Project Managers: Making vulnerable investments climate resilient http://www.longfinance.net/programmes/london-accord/la-reports.html?view=report&id=390	UGU DM, SDF, IDP, DWS		**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
CBA	Community Based Water Quality Monitoring	Many water quality problems are caused due to communities being unaware of the different aspects of managing and maintaining the quality of water resources. Raising their awareness of appropriate practices will help them realise the grim realities of depleting water sources and at the same time help in engaging them in monitoring and maintenance.			**Priority 6:** Collaborative planning **Priority 8:** Clean Environment **Priority 9:** Peace and Stability *GGPP 9: Rural Community engagement* *CCI 3: Environmental Health Education* *CCI 2: Water Quality Monitoring*		
	Public awareness campaigns on sanitation, water-borne diseases and climate related health risks		UGU DM, DWS	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment **Priority 9:** Peace and Stability *GGPP 9: Rural Community engagement* *CCI 3: Environmental Health Education*		

Strategic Focus Area 2	Sustainable and equitable access to water.

Objective 2.1	Improved water resource management.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Conduct vulnerability assessments for water resources (ground and surface) and recharge areas in hotspot areas.	Refer to Climate Change Risk Profile and KwaZulu-Natal Water Reconciliation Strategy and identify priority catchments. Prioritise areas for interventions and consider future water security and allocations during development planning.	UGU DM, DPEMS, DWS	CAPEX: Desktop based – R 350 000 Comprehensive – R 1 500 000	**Priority 6:** Collaborative planning **Priority 8:** Clean environment		
	Comprehensive flood and drought risk assessment and management plan	Identify areas not suitable for infrastructure and settlement development based on flood/drought risk.	UGU DM Disaster Management	CAPEX: R 750 000	**Priority 6:** Collaborative planning **Priority 8:** Clean environment		
	Develop an Alien Invasive Management Plan			R 500 000	**Priority 6:** Collaborative planning **Priority 8:** Clean environment *CSI 13: Environmental Protection and Biodiversity Conservation Management*		

	Alien Invasive management project	Remove invasive alien plants (IAPs) from the riparian zones. Prioritise these on the basis of cost-effectiveness, in the short-term and in the future.	UGU DM, DPEMS	R 1 500 000 p.a.	**Priority 6:** Collaborative planning **Priority 8:** Clean environment *CSI 13: Environmental Protection and Biodiversity Conservation Management*		
	Address water leaks and rehabilitate or decommission aging infrastructure.	Reduce water and revenue losses. Focus on improving efficiencies of water use in both private and public sectors. In the public sector, fix leaks and hunt down unaccounted-for losses. Focus on excessive water users and establish reasons for use level.		Operational budget allocation per annum: R2 500 000	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing) *BSD 2: Upgrade and Repair of Aging Infrastructure*		
	Conduct best practice review and develop municipal policy relating to water efficiency, re-use and conservation.	Develop a grey water use policy requiring water intensive facilities to recover/re-use water. Develop and implement municipal guidelines for the rainwater harvesting, for communities and industry. Consider encouraging efficiency increases through pricing strategies.	UGU DM, DWS, DPMES, Local Municipalities	CAPEX: R 500 000	**Priority 6:** Collaborative planning **Priority 8:** Clean environment		

CBA	Public awareness campaigns on climate change projections and risks		UGU DM, DPMES, Community Services, Local Municipalities	OPEX	**Priority 4:** Education and Skills development (Skills Development, Education) **Priority 6:** Collaborative planning **Priority 8:** Clean environment **Priority 9:** Peace and Stability		
	Establish community/village based water resource management structures	Develop community-based water management, with the focus on building the capacity of existing water committees. Aim to devise a system of community-based water management in conjunction with the water provider or other strategic partners such as the private sector, agriculture, NGO's etc. The projects implies a shared responsibility for water sources will usually be supported by a wider education and empowerment initiative in the context of skills and knowledge requirements.	UGU DM, DWS	CAPEX: R 250 000 per community/village (village/community) OPEX: Implementation and maintenance	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 4:** Education and Skills development (Skills Development, Education) **Priority 6:** Collaborative planning **Priority 8:** Clean environment *GGPP 9: Rural Community engagement*		

	School water supply programmes in rural areas.	By focusing on children today and providing them with knowledge with regard to maintaining water quality and effective sanitation practices we will be securing the upcoming generation from the threats of water and sanitation related diseases. This will not only provide a hygienic environment in schools, the children will also convey the message back home.	UGU DM, DWS, Department of Education.	CAPEX: Context Specific	**Priority 4:** Education and Skills development (Skills Development, Education) **Priority 9:** Peace and Stability *GGPP 9: Rural Community engagement*		
	Establish micro-purification systems for areas without regular access to safe drinking water. Refer to guidance notes below	In case of rural areas, modern water purification technologies might not be viable. In villages, it is important that simple technologies that are easy to use and can be operated without much technical know-how be promoted. The price factor is also important as technologies with high operational and recurring costs might not be useful. Water purification can be carried out at the household level and at the community level.		CAPEX: Context Specific	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 8:** Clean Environment		
	Household level grey water systems			R 15 000 per household	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 8:** Clean Environment		

	Household level rain water harvesting systems			R 2 500 per household	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 8:** Clean Environment		

Guidance notes on micro water purification methods[123]:

Water Quality Issue	Treatment Methods
Turbidity	• Cloth Filtration • Slow Sand Filtration • Coagulation • Candle Filtration
Odour	• Aeration • Carbon Filtering using charcoal • Boiling
Colour	• Carbon Filtering using charcoal • Slow Sand Filtration
Bacterial Impurities	• Boiling • Chlorination • Ultra Violet Radiation - SODIS • Slow Sand Filtration

[123] WaterAid. 2008. Drinking water quality in rural India: Issues and approaches.

5.10.2 Climate resilient and low carbon development

Strategic Focus Area 1	Development of climate resilient, environmentally friendly and low carbon industries.

Objective 1.1		Establish supportive environment for the development of green and climate resilient industries.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: S – Short M – Medium L – Long Term	**Priority: L – Low M – Medium H - High**
Institutional	Conduct a baseline inventory of green industries and services in the Ugu District		UGU DM, POMES	OPEX	**<u>Priority 2:</u>** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Integrate the monitoring of climate resilient and green industries and services with the existing business registration system.		UGU DM, DPMES	OPEX	**<u>Priority 2:</u>** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Review and harmonize local policies (on trade, investment, environment, tourism, agriculture, etc.)	Objective is to provide a stable and unified policy environment for the greener operation of existing businesses/enterprises and the expansion/development of climate smart industries and services, such as green manufacturing, green tourism, LOHAS (lifestyle of health and sustainability), organic agriculture, sustainable forestry, and renewable energy.	UGU DM, DPMES, LEDET, DEA	OPEX CAPEX: (if outsourced) R 250 000	**<u>Priority 2:</u>** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) *LED 10: Review of LED sector Plans*		

	Review, develop and implement a system of incentives to encourage the use of climate resilient technologies and practices, local sustainable materials and supply chain, R&D, and commercialization of such technologies.	E.g. green procurement policy for municipalities.	UGU DM, LEDET	OPEX CAPEX: (if outsourced) R 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Review National Tourism Sector Strategy and align local plans.		UGU DM	OPEX CAPEX: (if outsourced) R 250 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Develop tourism policies integrating economic and resource conservation issues in the face of potential and observed consequences of climate change.	Risk transfer measures may include: • Insurance; • Emergency funds; • Micro-insurance.	UGU DM, LEDET	OPEX CAPEX: (if outsourced) R 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Support the development and implementation of risk transfer mechanisms for individuals and small to medium enterprises to increase capacity to cope with negative impacts of climate change.	Policy position	UGU DM, LEDET, Financial Service Providers	OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Assess the effects of climate change on special designated natural areas that attract tourists such national parks and forests	Refer to results of Climate Change Response Strategy	UGU DM	OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
CBA	Ensure accurate information reaches current and potential tourists on behaviours and uses that ensure environmental quality and ecosystem resiliency at popular travel destinations				**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

Objective 1.2	Enforcement of regulations.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
	Establish and enforce emissions limits particularly under the Air Quality Act		UGU DM, DPMES	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Increase capacity of relevant municipal agency for environmental compliance monitoring.		UGU DM, DPMES	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Enforce compliance with environmental legislation.		UGU DM, DPMES	OPEX	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment *MTID 18: Legal Compliance*		

Objective 1.3	Capacity building in support of green climate resilient industries and services.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Develop and implement a Greenhouse Gas emission inventory	Include an industry pollutants transfer registry for other pollutants apart from Greenhouse Gasses.	UGU DM, DPMES	OPEX CAPEX: (if outsourced) R 500 000	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Increase capacity of relevant municipal agency for environmental compliance monitoring.		UGU DM, DPMES		**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Identify training providers for government and industries		UGU DM, DPMES		**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Engage the private sector as a partner through market and investment opportunities.		UGU DM, DPMES		**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
CBA	Establish partnerships with industry associations and NGO in the development and dissemination of knowledge products on green business practices.		UGU DM, DPMES		**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

Strategic Focus Area 2	Sustainable livelihoods and job creation.

Objective 2.1	Increased livelihood opportunities in the green economy.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**

Institutional	Support business and job opportunities in emerging green sectors	Policy position	UGU DM	OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Promote education and job training programs to re-tool workforce to take advantage of green economy growth	Policy position	UGU DM	OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Analyse long and short term jobs trends to identify which sectors/occupations will be positively/negatively impacted, with an emphasis on job creation opportunities		UGU DM, DPMES	CAPEX: R 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Review existing Growth and Development Strategy to align it with Climate Change Response Strategy and KwaZulu Natal Green Economy Plan	Initiate an economic development strategy focused on the goods and services that will be required to implement climate adaptation,	UGU DM	CAPEX: R 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		

Strategic Focus Area 3	Climate resilient municipalities.

Objective 3.1	Climate resilient municipal infrastructure.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**

Institutional	Integrate climate change resilience into Terms of Reference for development new infrastructure.	Places responsibility of climate resilience in the implementing agency to adapt design standards. Refer to Guidelines for Project Managers: Making vulnerable investments climate resilient http://www.longfinance.net/programmes/london-accord/la-reports.html?view=report&id=390 Refer to a**daptation cost of road infrastructure** in guidance notes below.	UGU DM, Infrastructure Services, Supply Chain Management	OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		
	Review existing physical frameworks and planned infrastructure development based on risk identified in the Climate Change Response Strategy		UGU DM, Infrastructure Services, IDP Committee, DPMES	OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		
	Evaluate and improve capacity of storm water systems for high intensity rainfall events	• Conduct review and identify where capacity is inadequate; • Increase capacity, • Consider integration of onsite storm water management and part of low impact development techniques	UGU DM, Infrastructure Services, DPMES	CAPEX for review of storm water infrastructure: R 1 000 000 CAPEX for increasing capacity of existing infrastructure: TBD	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		
	Maintenance of gutters drainage ditches and culverts		UGU DM, Infrastructure Services	OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		

Objective 3.2	Climate resilient land use planning and housing.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Review municipal development plans based on climate risks	Refer to Risk Assessment Section of the Climate change Response Strategy. Guide future development away from vulnerable/hazard prone areas	UGU DM, DPMES, Local Municipalities	OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		
	Develop municipal or city sustainability plan focusing on sustainable production and consumption, green workforce, transit-oriented development, and CC adaptation and building retrofits.	Refer to National Urban Development Framework (2016)	UGU DM, Local municipalities	CAPEX: R 1 000 000	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing) **Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Implement an integrated land use transport plans to reduce average travel distance and time between work and residence, and promote energy Conservation.	Refer to Integrated Transport Management Plan	UGU DM, Local Municipalities	OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		

	Integrated Green Building Council of South Africa's Green Building Standards in municipal development planning			OPEX	**Priority 1:** Infrastructure investment (roads, water, sanitation, electricity, housing)		
CBA	Promote uptake of hazard insurance for home owners.	Policy position		OPEX	**Priority 3:** Financial Viability (Clean Audit, Corruption)		

Objective 3.3	Climate responsive sold waste management.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Conduct waste reduction through segregation and composting at municipal landfills	Already being implemented, but potential exists to expand	UGU DM, Local Municipalities, DPMES	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Promote expansion of in-store recycling programs especially for electronic waste and low value recyclables.		UGU DM, Local Municipalities, DPMES	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

Guidance notes:

Adaptation Costs for Paved Rural Road Infrastructure

						Adaptation Cost for Paved Rural Roads (per km)			Adaptation Cost Factor (relative to no adapt)		
Stressor / Cause	**Effect**	**Mechanism**	**Adaptation Measure**	**Applicable Timing**	**Adaptation Benefit**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
Temperature	Increased temperature leads to – accelerated aging of binder	Increased loss of bitumen volatiles	Surface Rejuvenation Spray to restore surface by applying cutback binder	**Additional** Periodic Maintenance Intervention every 5 yrs.	Retain surfacing typical design life	ZAR 284,704.00	ZAR 231,424.00	ZAR 220,768.00	1.22	1.23	1.29
			Construct dense seals (e.g. Sand Seal, Otta Seal or Cape Seal). Typically Cape Seals on heavy trafficked roads	Next Periodic Maintenance cycle or	Increase surfacing design life to +-12yrs (Cape Seal)	ZAR 1,339,200.00	ZAR 1,037,700.00	ZAR 941,400.00	1.05	1.05	1.22
				next Rehabilitation event (whichever comes first)		ZAR 3,602,880.00	ZAR 2,397,410.00	ZAR 1,567,080.00	1.02	1.02	1.12
	Increased temperature leads to - rutting (of asphalt), bleeding and flushing (of seals)	Bituminous binder phase loses stiffness	Adoption of base bitumen binders with higher softening points (including polymer modification) for surface seals and asphalt	Next Periodic Maintenance cycle or	Retain surfacing typical design life	ZAR 1,339,200.00	ZAR 1,037,700.00	ZAR 805,264.00	1.05	1.05	1.04
				next Rehabilitation event (whichever comes first)		ZAR 3,602,880.00	ZAR 2,397,410.00	ZAR 1,430,944.00	1.02	1.02	1.02

Precipitation	Increased precipitation leads to increased average moisture content in subgrade layers – reduced load carrying capacity	Precipitation enters through verge and gravel shoulders	Add wider paved shoulders to improve surface drainage	Next Rehabilitation event	Retain pavement typical design life (+-20 to 30yrs)	ZAR 4,099,180.00	ZAR 3,048,760.00	ZAR 1,821,820.00	1.16	1.30	1.30
			Increase base strength (thickness and/or quality) to increase protection of subgrade layers	Next Rehabilitation event	Retain pavement typical design life (+-20 to 30yrs)	ZAR 4,339,720.00	ZAR 2,599,430.00	ZAR 1,819,020.00	1.23	1.11	1.30
		Precipitation enters through cracks in road surface	Increase frequency of reseal cycle (15 yr. cycle in dry areas reduced to 8yr cycle in wet areas)	**Additional** Periodic Maintenance Interventions	Retain pavement typical design life (+-20 to 30yrs)	ZAR 1,271,600.00	ZAR 989,600.00	ZAR 773,440.00	1.88	1.88	1.88
			Increase base strength (thickness and/or quality) to increase protection of subgrade layers	Next Rehabilitation event	Retain pavement typical design life (+-20 to 30yrs)	ZAR 4,339,720.00	ZAR 2,599,430.00	ZAR 1,819,020.00	1.23	1.11	1.30

Adaptation Costs of Gravel Roads

						Adaptation Cost (per km)			Adaptation Cost Factor (relative to no adapt)		
Stressor / Cause	**Effect**	**Mechanism**	**Adaptation Measure**	**Applicable Timing**	**Adaptation Benefit**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
Temperature	None										
Precipitation	**Increased precipitation** leads to increased average moisture content in subgrade layers – reduced load carrying capacity	Precipitation enters through verge and gravel shoulders	Increase gravel wearing course thickness to increase cover and protection of subgrade layers	Next Regravel treatment event	Retain pavement typical design life (+-5 to 8yrs)	ZAR 697,245.00	ZAR 608,062.50	ZAR 319,125.00	1.74	1.74	1.37
		Precipitation enters through gravel road surface	Upgrade road to paved	Next Regravel treatment event	Savings on gravel road maintenance and Vehicle Operating Costs	ZAR 3,648,120.00	ZAR 2,268,720.00	ZAR 1,569,780.00	9.11	6.49	6.74
			Increase gravel wearing course thickness to increase cover and protection of subgrade layers	Next Regravel treatment event	Retain pavement typical design life (+-5 to 8yrs)	ZAR 697,245.00	ZAR 608,062.50	ZAR 319,125.00	1.74	1.74	1.37
	Decreased precipitation leads to - increased gravel losses	ravelling and corrugations of dry dusty road surface	Upgrade road to paved	Next Regravel treatment event	Savings on gravel road maintenance and Vehicle Operating Costs	ZAR 3,648,120.00	ZAR 2,268,720.00	ZAR 1,569,780.00	9.11	6.49	6.74

	and poor ride quality		Increase regravel and blading frequency in dryer areas	Additional Regravel Interventions **(refer to Gravel Loss precipitation model).**	Retain ride quality and gravel thickness over typical design life (+- 5 to 8yrs)	function of old vs new frequency	function of old vs new frequency	function of old vs new frequency	function of old vs new frequency	function of old vs new frequency	function of old vs new frequency

5.10.3 Energy Efficiency and Demand Side Management

Strategic Focus Area 1	Energy Efficiency and Conservation.

Objective 1.1		Develop implement a government energy management programme.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: S – Short M – Medium L – Long Term	**Priority: L – Low M – Medium H - High**
Institutional	Implement energy management guidelines for al municipal facilities.	• Local governments can save energy by upgrading heating, ventilating and air-conditioning systems and replacing other electric powered equipment with more efficient equipment. • Incorporate Energy Efficiency into New Municipal Buildings	UGU DM, All departments and facilities	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Establish feasibility of alternative energy sources for public lighting		UGU DM	CAPEX: Context specific	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		

Objective 1.2	Increased energy efficiency in private sector and on community level.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation: **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
CBA	Awareness Campaigns of electricity management and conservation.		UGU DM, Local Municipalities, ESKOM	OPEX	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing) **Priority 8:** Clean Environment		

Strategic Focus Area 2	Green transport

Objective 2.1	Green transport strategies and fuel conservation integrated into development plans.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation **S – Short** **M – Medium**	**Priority:** **L – Low** **M – Medium** **H - High**

						L – Long Term	
Institutional	Develop and Implement a green fleet management programmes for municipal departments.	http://www.unep.org/tnt-unep/toolkit/	UGU DM	OPEX CAPEX (if outsourced): R 500 000	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing)		
	Implement national policy guidelines on integrating land-use and transport planning.	Refer to Integrated Urban Development Framework (2016) and National Guidelines for the Development of Spatial Development Frameworks	UGU DM, DPMES	OPEX	**Priority 1:** Infrastructure Investment (Roads, Water, Sanitation, Electricity, Housing)		

5.10.4 Biodiversity and Ecosystems Management

Strategic Focus Area 1	Protection and rehabilitation of ecosystems and ecosystem services

Objective 1.1	Implementation of climate change response strategies for key ecosystems						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Conduct a comprehensive biodiversity risk and vulnerability assessment	Include as component of Strategic Environmental Analysis (SEA)	UGU DM, DPMES	CAPEX: R 1 000 000	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Review zoning guidelines for different ecosystems	Should also be addressed recommendations stemming from a risk and vulnerability assessment.	UGU DM, DPEMS	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Identify and demarcate vulnerable ecological management zones requiring	Should also be addressed recommendations stemming from a risk and vulnerability assessment.	UGU DM, DPEMS	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

5.10.5 Food Security and Agriculture

Strategic Focus Area 1	Enhanced resilience of agricultural production and distribution systems from climate change.

Objective 1.1	Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Conduct comprehensive district level vulnerability and risk assessments for the agriculture sector	Conduct of studies on the impacts of climate change on major crops and livestock based	UGU DM,DPMES, Community Service Dept., LDA	CAPEX: R 1 000 000 – R1 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Advocate the development and adoption of climate-resilient crop and livestock production systems and technologies in the commercial sector	Awareness Campaigns	UGU DM, Agricultural Development Forums	CAPEX: R250 000 OPEX: Stakeholder engagement and forum participation.	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Establish partnership with the University of KwaZulu Natal for targeted research and dissemination of results		UGU DM, Local Municipalities, University of KwaZulu Natal	OPEX	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development)		
	Establish a platform for collating weather data and analysis in the context of climate change and develop channels for communicating weather information to farmers across the district		UGU DM, Community Services, LDA, NGO's	CAPEX: R 500 000 + OPEX (Operation and Maintenance)	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
CBA	Public awareness campaigns on climate change projections and risks		UGU DM, DPMES, Community Services, Local Municipalities	OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 8:** Clean Environment		

Objective 1.1	Climate-sensitive agriculture policies and plans				
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**To be determined by UGU DM**

					Mainstreaming Opportunity in IDP	**Time Horizon for Implementation** **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Review and align existing plans policies on food production and distribution	Align Climate Change Strategy, Disaster Management Plans, Spatial Development Framework, Agricultural Strategies, Growth and Development Strategies	UGU DM	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Conduct annual CC adaptation planning and budgeting.		UGU DM, IDP Committee	OPEX	**Priority 3:** Financial Viability (Clean Audit, Corruption) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Rehabilitation of land owned by UGU DM to address the concern regarding the loss of agriculturally productive land and natural resources		UGU DM, DPMES, LEDET	R 6500 p/ha	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

	Build institutional capacity by training relevant municipal staff on climate change and response	Send officials on trainer courses to develop their capacity in terms of facilitating climate change response	UGU DM, SALGA, National Treasury	R 25 000 per staff member trained	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development)		
CBA	Develop a subsistence farming irrigation policy to facilitate the responsible use of water for irrigation.		UGU DM, DPMES, DWS, LDA	R 500 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Monitor, repair and rehabilitate irrigation infrastructure to reduce water losses and improve irrigation efficiency		UGU DM, Water and Infrastructure Services, LDA	R 2 500 000 Per annum	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

Strategic Focus Area 2	Climate resilient agricultural communities.

Objective 2.1	Enhanced capacity for Climate Change Adaptation in farming communities and industry.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**		**To be determined by UGU DM**

					Mainstreaming Opportunity in IDP	**Time Horizon for Implementation** **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
CBA	Develop education, training and extension services and establish farmer support programmes in vulnerable communities.	Agricultural extension consists of: • the dissemination of useful and practical information related to agriculture, including improved seeds, fertilizers, implements, pesticides, improved cultural practices, and livestock to rural communities in a systematic, participatory manner, with the objective of improving their production, income, and (by implication) quality of life.	UGU DM, DPMES, LDA, National Treasury, NGO's	Expanded extension services Year 1 CAPEX: R 500 000 per community for services Year 2, 3: OPEX for Operation and Maintenance Comprehensive Farmer Support Programmes Year 1 CAPEX: 2 500 000 per annum per community Year 2, 3: CAPEX: R 500 000 + OPEX	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development)		
	Establish field schools	The Farmer Field School (FFS) is a group-based learning process. During the FFS, farmers carry out experiential learning activities that helped them understand the impact of climate change. These activities involve simple experiments, regular field observations and group analysis. The knowledge gained from	UGU DM, DPMES, LDA, DWS, NGO's	CAPEX: R 1 000 000 p.a. for 50 students + OPEX (Operation and Management)	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 4:** Education and Skills development (Skills Development, Education)		

		these activities enables participants to make their own locally specific decisions about crop management practices.					
	Implementation and utilization of community gardens for agriculture and food production.		UGU DM,DPMES, Community Services, NGO's	R 100 000 per garden			

Objective 2.2	Enhanced social protection for farming communities.						
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation S – Short M – Medium L – Long Term	**Priority: L – Low M – Medium H - High**
Institutional	Identify and implement climate change risk transfer and social protection mechanisms for agriculture.	Micro-financing and Insurance mechanism for commercial and subsistence farmers	UGU DM, Local Economic Development, National Treasury	CAPEX: R 1 000 000	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		

CBA	Organize and train farmers and farmer organizations in accessing financing and insurance		UGU DM, LDA, SALGA	R 50 000 per 1 day training session for 15 participants.	**Priority 2:** Economic and Sectoral Development (Job Creation, Employment, LED Projects, Tourism, Agriculture, Rural development) **Priority 4:** Education and Skills development (Skills Development, Education)		

Specific activities for inclusion in the projects put forward in the action plan outlined above Included but are not limited to: (please note the suitability of the following activities will be context specific and may not be suitable for universal implementation)

- Practices to reduce soil loss (erosion) and increase soil water retention such as no-till or conservation tillage, no-burn policy;
- Conserve and improve soil health and water retention through biological farming systems, increase carbon content and microbial activity e.g. crop rotation, inter-cropping, mulching, cover crops, working in weeds;
- Improve irrigation efficiency (demand), change to drip irrigation
- Secure reliable supply of fresh water for irrigation (supply management);
- Preserve groundwater (this must be unpacked by the water sector);
- Remove and control alien invasive species to restore stream flow;
- Introduce stricter measures and increase monitoring capacity to reduce pollution and salinization of fresh water resources;
- Change crops to varieties more suited to the new conditions, this may require developing new infrastructure, and developing markets;
- Identify, monitor and control pests and diseases (both existing and new) using IPM (Integrated Pest Management);
- Extension of weather station network co-ordinated and managed by a central agency, with regular accurate information and forecasts to
- farmers, early-warning systems;
- Move agricultural activities to more appropriate/conducive areas;
- Change from livestock to crops where appropriate;
- Provide rural farmers with agrometeorological advice;
- Investment in more efficient irrigation technology;
- Insurance and risk sharing mechanisms;
- Education on water-saving practices and changes in crop choices;

Document and assess indigenous knowledge and coping strategies;
- Seed banks;
- Develop scientifically-based but suitably packaged information systems to help farmers with decision-making, collate various sources of expert knowledge;
- Develop efficient extension service for better technology transfer and adoption of sustainable/climate resilient farming practices
- Better integrated land use planning and economic development using CC scenarios, climate topologies, resource base, and GIS based crop census;
- Maintain and develop research capacity locally, incl. Indigenous knowledge base;
- Improve trade equity, market access, benefit from new opportunities in global context;
- Plant indigenous forests to prevent soil erosion, fires, floods for whole region
- Implement different planting dates;
- Increased use irrigation;
- Adjustments to livestock management;
- Soil conservation techniques/erosion control;
- Implement crop diversification;
- Change quantity of land under cultivation;
- Change from crops to livestock where appropriate;
- Change from farming to non-farming activity, i.e. diversify livelihoods;
- Change use/application of fertilisers and chemicals;
- Increased use water conservation techniques;
- Adjust growing season;
- Agroforestry;
- Food storage;
- Recycling of grey water.
- Integrated and use planning including climate change scenarios
- Increased research;
- Employment of additional extension officers;
- Sustainable land reform;
- Shift to less water intensive crops.

5.10.6 Human Security: Disaster Management and Public Health

Strategic Focus Area 1	Integrated Climate Change Response and Disaster Management.

Objective 1.1		Mainstreaming of Climate Change Response and Disaster Risk Reduction.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation S – Short M – Medium L – Long Term	**Priority: L – Low M – Medium H - High**
Institutional	Identify district climate risks and vulnerable sectors	Completed as part of the UGU DM Climate Change Response Strategy	UGU DM, DPMES	OPEX: Implementation	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
	Conduct multi-stakeholder Climate Change Response and Disaster Management planning based on results of the Climate Change Response Strategy		UGU DM, All departments	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment **Priority 9:** Peace and Stability		

Objective 1.2		Enhanced institutional capacity for disaster risk reduction and climate change response.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation S – Short M – Medium L – Long Term	**Priority: L – Low M – Medium H - High**

Institutional	Organise and mobilise local networks of climate change practitioners and resources that can provide assistance to Local Municipalities and communities in terms of climate change response	E.g.: • http://www.adaptationnetwork.org.za/ • http://www.emg.org.za/programmes/climate-change • http://www.climatefruitandwine.co.za/	UGU DM	OPEX	**Priority 5:** Institutional Integration and Coordination (Institutional development, review of Organogram, Workforce, Principles development) **Priority 6:** Collaborative planning **Priority 8:** Clean Environment		
CBA	Develop and implement clear public awareness programmes	Workshops, printed material and radio broadcasts. Messages to incorporate the understanding of the values, concerns and interests of those who will need to take action	UGU DM	OPEX	**Priority 6:** Collaborative planning **Priority 8:** Clean Environment **Priority 9:** Peace and Stability		
	Increase the districts capacity to disseminate early warnings and weather forecasting information to vulnerable sectors and communities	Refer to guidance notes on EWS and costing below.			**Priority 6:** Collaborative planning **Priority 8:** Clean Environment **Priority 9:** Peace and Stability		

Guidance note:

Cost of community based early warning systems:

Item	Cost	Details
Awareness-raising campaign including the involvement of authorities, institutions and the population.	R 150 000 per community	Workshops, printed material and radio broadcasts
Installation of a local weather station	R 25 000	
Creation and analysis of information: forecasting protocols	R 150 000 per study	1 study for whole districts
Implementation of a communication system: warning notices, mechanisms to disseminate prevention, mitigation and adaptation measures	R 75 000	Design of news bulletin and radio announcement formats and models, broadcasting via local networks.
Training for local EWS operators and promoters	R 250 000	Around 20 people per district.
Operating costs		
Maintenance	R 1 000 per station	
Radio broadcast	R 100 000 per annum	Monthly broadcast on district level
Communications	R 500 000 per annum	SMS, and additional electronic communications

Adapted from Damman, 2008.

Strategic Focus Area 2	Preparedness of health and social protection services.

Objective 1.2		Improved response capacity of public health.					
	Project/Action	**Details**	**Implementing Agency**	**Estimated budget**	**Mainstreaming Opportunity in IDP**	**To be determined by UGU DM**	
						Time Horizon for Implementation **S – Short** **M – Medium** **L – Long Term**	**Priority:** **L – Low** **M – Medium** **H - High**
Institutional	Liaise with national and provincial Dept. of health on the development of health surveillance systems	Lobby for the develop and implement information system for the monitoring of all-cause mortality data, hospital admissions, public health line phone calls, GP's records on morbidity data, ambulance calls, fire brigade interventions and emergency department visits.	UGU DM	OPEX	**Priority 7:** Reduce HIV & Aids		
	Assess capacity of local health facilities and personnel for emergency preparedness and response.	• Assess resources and capacity; • Assess whether personnel understand the clinical manifestations of climate related health risks; • Health care facilities should have dedicated response plans	UGU DM, Community Service in liaison with provincial Dept. of Health	TBD	**Priority 7:** Reduce HIV & Aids		

CBA	Set up dedicated telephone hotline during periods of high risk.		UGU DM, Community Service in liaison with provincial Dept. of Health	OPEX	**Priority 7:** Reduce HIV & Aids **Priority 9:** Peace and Stability		

5.11 Decision making support Matrix

Decision making related to climate change important for making decisions about sustainable development, considering the threat climate change poses to sustainability of natural and human systems. Projected climate change poses a significant potential threat to future development activities and the economic wellbeing of the Ugu DM and its residents. The Ugu DM's decision-makers routinely make decisions that influence both climate change mitigation and adaptation, but are of a broader scope than strategies specifically related to climate change. These decisions relate to economic development, environmental sustainability, and social equity issues within the District. In this context, economic, environmental, social interactions could be identified and analysed and effective sustainable development policies formulated by linking and articulating them explicitly with climate change policies.

The matrix below present the climate risk per LM, the physical impact on the ground and the associated consequences. Furthermore they present community and institutional adaptation and mitigation options tailored for the urban and rural areas and for subsistence and commercial agriculture.

Urban / semi urban areas								
	Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast	Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni	Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo	Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Physical Impacts	Higher water volumes; higher water table; increased usage duration water supply; more water in rivers/streams.	Increased flooding in summer; more overland flow; more severe storms.	Unseasonal weather can change the rainfall onset and cessation catching the communities unaware and unprepared. May also impact disaster relief.	Decreased water availability; less water available for domestic use; lower water table; pressure on dam infrastructure.	Higher temperatures for long periods, increased evaporation; Enhanced urban heat island effect.	Significantly higher temperatures, higher evaporation from dams; enhanced urban heat island; impacts health, increased demand for cooling and water.	Higher night time temperatures.	Inundation of coastal low lying areas, beach and estuary bank erosion; ecological damage to estuaries
Local Negative Consequence	More overland flow due to impermeable surfaces; traffic congestion; Increased flood potential; potential increase in vector and pathogen transmission leading to decreased health; damage to infrastructure, damages poorly built/located houses.	Increased flood potential; damage to storm water infrastructure; increased pressure on disaster relief; damage to infrastructure and limitation of services; damages poorly built/located dwellings.	Planning and development may have to change timelines due to unsuitable weather. Services may need to alter time frames on delivery.	Water stress may result in malnutrition, decreased health, decreased food availability and quality, decreased water quality; Urgent reprioritisation of water usage. Managing water use demand	Prolonged heat stress and increased demand for cooling; decreased human productivity in hotter temperatures, increased metabolic rate resulting in higher food demand, increased temperature favours rodent and pathogen survival - increased disease. Population discomfort; further stress on water resources.	Population discomfort; increased demand for cooling; decreased human productivity in hotter temperatures; heat stresses; increased metabolic rate resulting in higher food demand, increased temperature favours rodent and pathogen survival - increased disease. Drying of vegetation - increased fire risk.	Heat doesn't escape urban areas at night and there is no rest bite for communities; increased cooling demand though decrease in heating demand. Less sicknesses exacerbated by cold temperatures.	Damage infrastructure; reduce residential and commercial property value; increased vulnerability; reduced aesthetic appeal and tourism. May deepen certain ports.
Local Positive Consequence	More water available. Water restrictions can be removed.	More water available. Water restrictions can be removed.	May attract tourists during seasons when tourism is usually low, thus increasing economic growth in certain areas.	Less water-borne diseases; Less antibiotic use because of less diseases infecting people and animals. Less breeding area for mosquitoes therefore malaria outbreaks will decrease.	Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures.	Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures.	Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures.	some ports will be deepened by sea level rise which reduces the need for dredging
Community based Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					

Urban / semi urban areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Improved sanitation	eliminate groundwater contamination and minimises diseases from spreading	eliminate groundwater contamination and minimises diseases from spreading	eliminate groundwater contamination and minimises diseases from spreading					
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Climate responsive solid waste management	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Managing solid waste prevents it from entering the ocean
	Fire management				Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	
	Enhanced institutional capacity for disaster risk reduction and climate change response	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts
	Improved response capacity of public health	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	Disease prevention and response minimises the risk of transmission and spread of the infection	

Urban / semi urban areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Enhanced capacity for emergency response procedures	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources
Institutional adaptation options	Supportive policy context for the integration of climate change response and water resource management	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	
	Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Climate resilient municipal infrastructure	Improved capacity of storm water systems and gutters	Improved capacity of storm water systems and gutters	Improved capacity of storm water systems and gutters					
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Climate responsive solid waste management	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Managing solid waste prevents it from entering the ocean

Urban / semi urban areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Adaptation of road infrastructure	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Using more drought resistant construction materials prevents warping, buckling and cracking of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Shoreline stabilisation structures such as seawalls can prevent damage to roads caused by sea level rise
	Mainstreaming of Climate Change Response and Disaster Risk Reduction	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact
	Enhanced institutional capacity for disaster risk reduction and climate change response	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts
	Improved response capacity of public health	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	
Community based mitigation options		Climate resilient land use planning and housing. Alternative energy and efficiency (Solar cooker, Solar electrification, Solar borehole pump, Wind pump, Micro hydropower, Biogas digester, Energy efficient stoves and ovens, Heat retention cooker). Increased energy efficiency in private sector and on community level. Increased livelihood opportunities in the green economy. Green transport strategies and fuel conservation.							
Institutional mitigation options		Climate resilient land use planning and housing. Climate resilient municipal infrastructure. Alternative energy and efficiency. Provide incentives for energy efficiency when supplying new connections. Increased energy efficiency in private sector and on community level. Develop and implement a government energy management programme. Establish supportive environment for the development of green and climate resilient industries. Enforcement of regulations. Capacity building in support of green climate resilient industries and services. Increased livelihood opportunities in the green economy. Green transport strategies and fuel conservation integrated into development plans.							

Commercial agriculture								
	Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast	Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni	Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo	Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Physical Impacts	Higher water volumes; higher soil water table; increased usage duration of boreholes and centre pivots; more water in irrigation schemes and dams. flood crops, food insecurity, loss of livelihoods, malnutrition, impacts health	Increased flooding in summer; physical damage to crops during severe storms and overland flow. Removal of nutrients from soils due to leaching and erosion in fallow fields.	Unseasonal weather can change the rainfall onset and cessation catching the farmers unaware and unprepared if they have not looked at seasonal forecasts. unpredictable rainfall means that farmers can't plan for the season, may result in a loss of livelihoods if they planned for a rainy season but it's a dry season	Lower rainfall volumes will put pressure on the farmers and less water available for irrigation if regional water priorities change; lower water table; drying of boreholes and centre pivots.	Higher temperatures for long periods, increased evaporation and transpiration from crops will leave them drier. Reduces water availability.	Significantly higher temperatures, higher evaporation and evapotranspiration from crop areas.	Higher night time temperatures.	Inundation of coastal low lying agricultural areas increases salinity of water and soil.
Local Negative Consequence	Increased flood potential; increased erosion; can negatively affect large crop areas; may have an influence of crop variety and growth may lead to additional field maintenance; increase nutrient leaching from rainfall in unused rotated fields decreasing fertility; can also provide better water security and enhance farming activity	Increased flood potential; increased erosion; will need better water management on the farm; negative impact on crop and livestock. Potential crop failure and loss leading to food security pressures. Will need further fertilizer to replace lost nutrients.	Crop suitability may change and favour other varieties/crops. Planting/harvesting regime becomes problematic. Shortened rainfall duration puts additional pressure on the workers; may leave crops immature impacting quality and yield volumes having financial repercussions for the farmer. Could result in food insecurity.	Irrigated crop and livestock significantly impacted due to water stress; may reduce crop yield and quality; livelihood impacts; food insecurity; negative impacts on soil nutrient content.	Prolonged heat stress on crop and livestock; decreased livestock productivity, increased metabolic rate resulting in higher animal food demand; heat stress on crops reducing moisture, yield and quality. May need a different crop/variety. Affects food security; threat to livelihoods.	Significant impact on crop and livestock, may lead to death; heat stress of labourers. Less moisture in the soils for crops and vegetation/grasses for livestock.	Increased heat stress and no respite for workers and livestock; pests increase activity on warmer nights decreasing yield. Temperature impacts the growth rate and cycle. Less sicknesses exacerbated by cold temperatures.	Increased water and soil salinity will reduce fertility of soil impacting livelihoods, crop yield and quality. May decrease available water for irrigation.
Local Positive Consequence	Can store excess water for winter.	Can store excess water for winter.	Changes the migration patterns of birds and animals that usually eat crops.	Less water-borne diseases; Less yard maintenance is required as grass does not grow as much as when it rains; In the Kruger National Park droughts help to reduce excess numbers of some species e.g. impalas. Some farmers may have to sell their farms due to poor success if their crops which gives them the opportunity to learn new	Inspires technology innovation out of desperation.	May reduce the presence/longevity of certain pests such as worms as temperatures become too extreme for them	Less frost that kills vegetation/crops.	Bigger area for aquaculture

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
					skills in other business sectors.				
Community Based Adaptation Options	Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced and energy can be saved by planting crops in places that best suit their needs and planting drought tolerant crops	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Crop yield can be increased by planting salt tolerant crops
	Climate-sensitive agriculture policies and plans	More agriculturally productive land available, increased food security, erosion control	More agriculturally productive land available, increased food security, erosion control	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	

Commercial agriculture		Increase annual rainfall	Increased rainfall intensity in summer	Seasonal rainfall shifts	Drought potential	Increased temperatures/heat wave incidence	Increased extreme temperature days	Decreased number of cold nights	Sea level rise
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Enhanced capacity for Climate Change Adaptation in farming communities and industry	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields
	Enhanced social protection for farming communities	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers
	Improved response capacity of public health	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	
	Climate-smart agriculture practices	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	
	Rangeland management	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	
	Soil fertility management	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Erosion and runoff control measures	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields					
	Gully management	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields					
	Stream/river bank management	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods					
	Farm management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Windbreaks or other farm boundaries could also protect crops from storm surges

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Waste management	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	
	Sustainable management of forestry	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	
	Sustainable fishing	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which can accommodate more fish, fertiliser can be produced from fish waste	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall intensity allows for bigger ponds which can accommodate more fish, fertiliser can be produced from fish waste	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which can accommodate more fish, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Make use of higher sea levels for aquaculture
	Sustainable management of wetlands	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	Storm surge buffering
	Alien and invasive plant management	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	Increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber. They can be burnt for	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	Allows native vegetation to establish along the coast protecting it from shoreline erosion

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Institutional Adaptation Options							heat generation on extreme cold days.		
	Fire management				Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	
	Enhanced capacity for emergency response procedures	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources
	Supportive policy context for the integration climate change response and water resource management	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively
	Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Climate resilient municipal infrastructure	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	water reservoirs with the appropriate capacity to capture and store rain that can be used during droughts	Climate resilient infrastructure that can withstand high temperatures needs less maintenance. Water reservoirs that store water and prevent it from evaporating.	Climate resilient infrastructure that can withstand extreme temperatures needs less maintenance. Water reservoirs that store water and prevent it from evaporating.		Water reservoirs along the coast must be able to prevent salt intrusion

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Implementation of climate change response strategies for key ecosystems	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services
	Adaptation of road infrastructure	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Using more drought resistant construction materials prevents warping, buckling and cracking of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Shoreline stabilisation structures such as seawalls can prevent damage to roads caused by sea level rise
	Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced and energy can be saved by planting crops in places that best suit their needs and planting drought tolerant crops	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Crop yield can be increased by planting salt tolerant crops
	Climate-sensitive agriculture policies and plans	More agriculturally productive land available, increased food security, erosion control	More agriculturally productive land available, increased food security, erosion control	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	
	Enhanced social protection for farming communities	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers
	Mainstreaming of Climate Change Response and Disaster Risk Reduction	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact
	Enhanced institutional capacity for disaster risk reduction and climate change response	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts

Commercial agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Improved response capacity of public health	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	
Community based mitigation options	Capacity building in support of green climate resilient industries and services. Increased livelihood opportunities in the green economy. Climate-smart agriculture. Waste management. Sustainable forestry.								
Institutional mitigation options	Alternative energy and efficiency. Increased livelihood opportunities in the green economy. Establish supportive environment for the development of green and climate resilient industries. Enforcement of regulations. Climate-sensitive agriculture policies and plans.								

Rural areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Physical Impacts		Higher water volumes; higher water table; increased usage duration of boreholes; more water in rivers/streams.	Increased flooding in summer; more overland flow; more severe storms.	Unseasonal weather can change the rainfall onset and cessation catching the communities unaware and unprepared. May also impact disaster relief.	Less water available for domestic use; lower water table; drying of boreholes.	Higher temperatures for long periods, increased evaporation.	Significantly higher temperatures, higher evaporation and evapotranspiration	Higher night time temperatures	Inundation of coastal low lying areas, beach erosion, ecological damage to estuaries
Local Negative Consequence		Increased flood potential; increased erosion; can negatively affect livelihoods, potential increase in vector and pathogen transmission leading to decreased health; damage to infrastructure, damages poorly built/located houses; can also provide better water security and enhance livelihoods.	Increased flood potential; increased erosion; impacts livelihoods; increased pressure on disaster relief; damage to infrastructure and natural areas; damages poorly built/located dwellings.	Vegetation suitability may change and favour invasive aliens. Planning and development may have to change timelines due to unsuitable weather.	Water stress may result in malnutrition, decreased health, decreased food availability and quality, decreased soil health and water quality,	Prolonged heat stress and increased demand for cooling; decreased human productivity in hotter temperatures, increased metabolic rate resulting in higher food demand, increased temperature favours rodent and pathogen survival - increased disease. Drying of vegetation - increased fire risk.	Increased demand for cooling; decreased human productivity in hotter temperatures; heat stresses; increased metabolic rate resulting in higher food demand, increased temperature favours rodent and pathogen survival - increased disease. Drying of vegetation - increased fire risk.	Increased heat stress and no rest bite for communities; increased cooling demand though decrease in heating demand. Less sicknesses exacerbated by cold temperatures.	Damage to dwellings to close to the ocean / tidal range. Reduced aesthetic appeal and tourism. Ecosystem impacted due to increased water and soil salinity.
Local Positive Consequence		Can store water for winter. Storing water means that people will not have to walk as far to obtain water.	Can store water for winter. Storing water means that people will not have to walk as far to obtain water.	Change in ecosystem services which might not usually be available.	Less water-borne diseases. Less antibiotic use because of less diseases infecting people and animals. Less breeding area for mosquitoes therefore malaria outbreaks will decrease.	Increased fires will increase the growth of fynbos vegetation. Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures. Snow in areas such as the Drakensberg will melt quicker providing water for the surrounding areas.	Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures.	Less sicknesses exacerbated by cold temperatures. Less shack fires as less fires have to be made to keep people warm. Fewer deaths caused by cold temperatures.	Discourages migration from the rural hinterland into urban areas along the coast resulting in rural development
Community based adaptation	Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					

Rural areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Climate responsive solid waste management	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Managing solid waste prevents it from entering the ocean
	Emergency response procedures	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources
	Improved response capacity of public health	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	
	Erosion and runoff control measures	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater recharged, improved crop yields					
	Gully management	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields					

Rural areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Stream/river bank management	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods					
	Improved sanitation	eliminate groundwater contamination and minimises diseases from spreading	eliminate groundwater contamination and minimises diseases from spreading	eliminate groundwater contamination and minimises diseases from spreading					
	Sustainable management of forestry	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	
	Sustainable fishing	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which can accommodate more fish	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall intensity allows for bigger ponds which can accommodate more fish	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which can accommodate more fish	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can be produced from fish waste	Make use of higher sea levels for aquaculture
	Sustainable management of wetlands	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	Storm surge buffering
	Alien and invasive plant management	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested	increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and	Increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and invasive plants can	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested	Allows native vegetation to establish along the coast protecting it from shoreline erosion

Rural areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Institutional adaptation options					for fodder, fuel and timber	invasive plants can be harvested for fodder, fuel and timber	be harvested for fodder, fuel and timber. They can be burnt for heat generation on extreme cold days.	for fodder, fuel and timber	
	Fire management				Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	
	Enhanced capacity for emergency response procedures	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources
	Supportive policy context for the integration climate change response and water resource management	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively	Ensures that water resources are managed effectively
	Implementation and enforcement of regulatory frameworks in the water sector	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality	Regulates effluent discharge and water quality					
	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Climate resilient municipal infrastructure	Improved capacity of storm water systems and gutters	Improved capacity of storm water systems and gutters	Improved capacity of storm water systems and gutters		Climate resilient infrastructure that can withstand high temperatures needs less maintenance	Climate resilient infrastructure that can withstand high temperatures needs less maintenance		

Rural areas									
		Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Climate resilient land use planning and housing	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced	Housing built in low risk areas, land is used appropriately, travel distances are reduced
	Climate responsive sold waste management	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from blocking drains and causing floods, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Reduced spread of diseases, save space, prevents waste from polluting water sources	Managing solid waste prevents it from entering the ocean
	Adaptation of road infrastructure	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Improved runoff drainage, reduced potholes	Using more drought resistant construction materials prevents warping, buckling and cracking of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Using heat resistant construction materials prevents warping, buckling, cracking and shifting of the road	Shoreline stabilisation structures such as seawalls can prevent damage to roads caused by sea level rise
	Implementation of climate change response strategies for key ecosystems	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services	continuity of ecosystem services
	Mainstreaming of Climate Change Response and Disaster Risk Reduction	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact
	Enhanced institutional capacity for disaster risk reduction and climate change response	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts
	Improved response capacity of public health	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	

Rural areas								
	Increased annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast	Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni	Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo	Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Community based mitigation options	Alternative energy and efficiency (Solar cooker, Solar electrification, Solar borehole pump, Wind pump, Micro hydropower, Biogas digester, Energy efficient stoves and ovens, Heat retention cooker), Forestry (Sustainable plantation forestry, Natural forest management, Protected forest reserves, Selecting beneficial trees), Increased energy efficiency in private sector and on community level, Establish supportive environment for the development of green and climate resilient industries. Capacity building in support of green climate resilient industries and services. Increased livelihood opportunities in the green economy.							
Institutional mitigation options	Forestry (Sustainable plantation forestry, Natural forest management, Protected forest reserves, Selecting beneficial trees), Develop implement a government energy management programme, Green transport strategies and fuel conservation integrated into development plans. Establish supportive environment for the development of green and climate resilient industries. Enforcement of regulations. Capacity building in support of green climate resilient industries and services. Increased livelihood opportunities in the green economy							

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Physical Impacts		Higher water volumes; higher water table; increased usage duration of boreholes; more water in rivers/streams.	Increased flooding in summer; physical damage to crops during severe storms and overland flow. Removal of nutrients from soils due to leaching and erosion.	Unseasonal weather can change the rainfall onset and cessation catching the farmers unaware and unprepared.	Lower rainfall volumes will put pressure on the farmers and less water available for irrigation; lower water table; drying of boreholes and rivers.	Higher temperatures for long periods, increased evaporation and transpiration. Reduces water availability.	Significantly higher temperatures, higher evaporation and evapotranspiration	Higher night time temperatures.	Inundation of coastal low lying agricultural and estuary areas.
Local Negative Consequence		Increased flood potential; increased erosion; can negatively affect livelihoods; may have an influence of crop variety usage; could rot crops if not maintained correctly; decreasing yield quality and quantity; can also provide better water security and enhance farming activity	Increased flood potential; increased erosion; impacts livelihoods, crop and livestock; damage to natural and farm areas; damages poorly built/located dwellings. Potential crop failure and loss leading to food security pressures.	Crop suitability may change and favour other varieties/crops. Planting/harvesting regime becomes problematic. Shortened rainfall duration may leave crops immature impacting quality and yield volumes.	Water stress may reduce crop yield and quality; livelihood impacts; food insecurity results in malnutrition, decreased health; increased irrigation demand; decreased food availability; negative impacts on soil nutrient content.	Prolonged heat stress on crops and increased irrigation demand; decreased livestock productivity, increased metabolic rate resulting in higher animal food demand; heat stress on crops reducing yield and quality. May need a different crop/variety. Affects food security; potential loss of livelihoods.	Significant impact on crops may lead to death; decreased livestock productivity; heat stress of labourers. Drying of crop may impact the growth cycle.	Increased heat stress and no rest bite for workers and livestock; pests increase activity on warmer nights decreasing yield. Temperature impacts the growth rate and cycle. Less sicknesses exacerbated by cold temperatures.	Increased water and soil salinity will reduce fertility of soil impacting livelihoods, crop yield and quality. May decrease available water for irrigation.
Local Positive Consequence		Can store excess rain for winter.	Can store excess rain for winter.	Changes the migration patterns of birds and animals that usually eat crops.	Less water-borne diseases. Less antibiotic use because of less diseases infecting people and animals. Less yard maintenance is required as grass does not grow as much as when it rains. Some farmers may have to sell their farms due to poor success of their crops which gives them the opportunity to learn new skills in other business sectors.	Inspires technology innovation out of desperation and gives the opportunity to teach people to adapt to climate change.	May reduce the presence/longevity of certain pests such as worms as temperatures become too extreme for them	Less frost that kills vegetation/crops.	Bigger area for aquaculture
Response Options	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced and energy can be saved by planting crops in places that best suit their needs and planting drought tolerant crops	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Crop yield can be increased by planting salt tolerant crops
	Climate-sensitive agriculture policies and plans	More agriculturally productive land available, increased food security, erosion control	More agriculturally productive land available, increased food security, erosion control	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	
	Enhanced capacity for Climate Change Adaptation in farming communities and industry	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields	Improved knowledge on farming techniques which enable communities to produce high yields
	Enhanced social protection for farming communities	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers
	Improved response capacity of public health	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	Enables institutions to improve public health and prevent the spread of diseases	
	Erosion and runoff control measures	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater	Runoff managed effectively, reduced erosion, reduced stream siltation and floods, increased infiltration, water conserved, groundwater					

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
		recharged, improved crop yields	recharged, improved crop yields	recharged, improved crop yields					
	Gully management	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields	Lowers risk of losing agricultural land, increased infiltration and soil moisture, increased crop yields					
	Stream/river bank management	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods	Reduced erosion, controlled runoff, reduced stream siltation, reduced risk of landslides and floods, prevents damage of property and crops by floods					
	Soil fertility management	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	Increases organic matter, maintains soil moisture, covers the soil, increased soil nutrients, improved crop yields	
	Rangeland management	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration and reduces runoff, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	allows vegetation to recover which protects soil from erosion, increases forage which also helps with water infiltration, ecosystem function and ecosystem services can improve	

Subsistence agriculture		Increase annual rainfall	Increased rainfall intensity in summer	Seasonal rainfall shifts	Drought potential	Increased temperatures/heat wave incidence	Increased extreme temperature days	Decreased number of cold nights	Sea level rise
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major Risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Climate-smart agriculture practices	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	Increased yields with less inputs, accumulation of soil nitrogen, improved weed and disease control, improved soil fertility, soil cover moderates soil temperature	
	Farm management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Using windbreaks protects crops from wind and rain, increased soil fertility, maintained borehole pumps ensures that water supply is not interrupted, improved grain storage, sustainable woodlot management	Windbreaks or other farm boundaries could also protect crops from storm surges
	Waste management	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	Reduced spread of disease, saves space, compost improves soil organic matter	
	Sustainable management of forestry	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion and stream siltation as well as flooding, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	Conserves water, reduces erosion, protected forests maintain climate conditions	
	Sustainable fishing	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall intensity allows for bigger	Aquaculture ponds can be used to catch runoff which reduces erosion. Increased rainfall allows for bigger ponds which	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold,	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes if stock is sold, fertiliser can	Water from aquaculture ponds can also be used for storage and irrigation, fish increases food security and incomes	Make use of higher sea levels for aquaculture

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
		can accommodate more fish	ponds which can accommodate more fish	can accommodate more fish	if stock is sold, fertiliser can be produced from fish waste	fertiliser can be produced from fish waste	be produced from fish waste	if stock is sold, fertiliser can be produced from fish waste	
	Sustainable management of wetlands	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, flood control, income from new business opportunities such as ecotourism, water filtration, infiltration, reduced siltation, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	water and food security, fertile soil, income from new business opportunities such as ecotourism, water filtration, infiltration, provide habitats for wildlife	Storm surge buffering
	Alien and invasive plant management	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	Increase water supply, reduce the risk of fires caused by high temperatures, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber. They can be burnt for heat generation on extreme cold days.	increase water supply, reduce the risk of fires, prevents biodiversity loss, alien and invasive plants can be harvested for fodder, fuel and timber	Allows native vegetation to establish along the coast protecting it from shoreline erosion
	Fire management				Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	Managing fires reduces the extent of damage	

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Enhanced capacity for emergency response procedures	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources	saves lives, property and resources
Institutional response options	Improved water resource management	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Reduces water losses, reduces water payments, improves health of waterbodies, recharges groundwater, stored water can be used during dry seasons	Prevents saltwater intrusion
	Implementation of climate change response strategies for key ecosystems	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services	Continuity of ecosystem services
	Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced and energy can be saved by planting crops in places that best suit their needs and planting drought tolerant crops	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Improved yields can be produced throughout the year and energy can be saved by planting crops in places that best suit their needs	Crop yield can be increased by planting salt tolerant crops
	Climate-sensitive agriculture policies and plans	More agriculturally productive land available, increased food security, erosion control	More agriculturally productive land available, increased food security, erosion control	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	Improved irrigation efficiency, more agriculturally productive land available, increased food security, reduced water losses	

Subsistence agriculture									
		Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni		Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast		Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni		Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu		Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe		Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo		Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
	Enhanced social protection for farming communities	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers	Access to financing and insurance for farmers
	Mainstreaming of Climate Change Response and Disaster Risk Reduction	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact	Reduces the extent of impact
	Enhanced institutional capacity for disaster risk reduction and climate change response	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts	Improves the capacity of institutions to effectively manage disaster risk and the associated impacts
	Improved response capacity of public health	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	Enables institutions to improves public health and prevent the spread of diseases	
	Climate resilient municipal infrastructure	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	Improved capacity of storm water systems and gutters, water reservoirs with the appropriate capacity to capture and store rain	water reservoirs with the appropriate capacity to capture and store rain that can be used during droughts	Climate resilient infrastructure that can withstand high temperatures needs less maintenance. Water reservoirs that store water and prevent it from evaporating.	Climate resilient infrastructure that can withstand extreme temperatures needs less maintenance. Water reservoirs that store water and prevent it from evaporating.		Water reservoirs along the coast must be able to prevent salt intrusion
Community based	Capacity building in support of green climate resilient industries and services. Increased livelihood opportunities in the green economy. Climate resilient land use planning and housing.								

Subsistence agriculture								
	Increase annual rainfall	**Increased rainfall intensity in summer**	**Seasonal rainfall shifts**	**Drought potential**	**Increased temperatures/heat wave incidence**	**Increased extreme temperature days**	**Decreased number of cold nights**	**Sea level rise**
Izinqoleni	Moderate risk	Moderate risk	Major risk	Major risk	Moderate risk	Moderate risk	Moderate risk	Insignificant Risk
Hibiscus Coast	Moderate risk	Major risk	Insignificant Risk	Moderate risk	Minimal Risk	Moderate risk	Insignificant Risk	Major Risk
Umdoni	Minimal Risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Major risk	Insignificant Risk	Major risk
uMuziwabantu	Moderate risk	Major risk	Major risk	Major risk	Moderate risk	Major risk	Minimal Risk	Insignificant Risk
Umzumbe	Minimal Risk	Insignificant Risk	Moderate risk	Moderate risk	Moderate risk	Major risk	Insignificant Risk	Moderate risk
Vulamehlo	Minimal Risk	Moderate risk	Moderate risk	Major risk	Moderate risk	Moderate risk	Minimal Risk	Insignificant Risk
Institutional mitigation	Alternative energy and efficiency. Increased livelihood opportunities in the green economy. Establish supportive environment for the development of green and climate resilient industries. Enforcement of regulations. Climate resilient land use planning and housing.							

5.12 Response support

It would be appropriate for the Ugu DM to invest in information management infrastructure that supplements its current information technology and enables the sharing of critical information during emergencies, and the comprehensive collection of risk information to inform climate change mitigation and adaptation initiatives.

▪ Essential Elements

The three essential elements of a complete information infrastructure are:

- Knowledge infrastructure. Encompasses the systems of measurement, methods of data visualization and exploitation, information analysis, event forecasting, knowledge modelling, and data and information management;
- Interconnectivity infrastructure. Encompasses the modes of communication employed to retrieve and distribute data; and to disseminate the information products, knowledge and understanding developed within the knowledge infrastructure;
- Integration infrastructure. Encompasses the process needed to ensure that the "mechanical" parts of the system are synchronized and that the "human" parts of the system are cooperating. The integration infrastructure is key to an effective overall information infrastructure as it addresses:
  - The tracking of system performance to user requirements;
  - The definition of standards and protocols necessary to ensure system interfaces are understood;
  - The methods, processes, and procedures to ensure quality and reliability of the knowledge base; and
  - The training needed to ensure users can effectively use the system.

▪ Information Cycle

Figure 77: Suggested Information Cycle

Information management is a systematic cycle as indicated above. The components as they relate to climate change response are described below.

- **Needs identification**

The first steps in establishing any information management system are to:

- Monitor the external environment to identify problems as they evolve and to be responsive to issues that are identified from outside the system.
- Define the problems to be addressed.
- Identify the information requirements that flow from them.
- Identify who is to benefit from the information.

- **Collection**

The collection plan (data gathering) should focus on the essential elements of information that have been identified, with collection priorities flowing from the profiles of need. In the process of data gathering it is important to employ all the data capture resources available (quantitative and qualitative). As part of the collection process the gathered information must be supplied to those who need it. Another important aspect is to involve the end users of the

information in the construction and development of the collection process too not only ensure that their needs are satisfied, but to also maximise acceptance of the process by the users as well as the establishment of solid baseline. Important management functions include planning, organizing, controlling and influencing the collection process.

- **Processing**

During this stage answers to the various questions are developed by converting data into information. This calls for a system that facilitates the collation, analysis, evaluation and interpretation of the data collected.

It is crucial to ensure that information processing for Climate Change Adaptation is not totally dependent on technology or the skill and experience of one person. Specialists could process data, but the end results need to be made available in a format that is easily understood and applicable. Therefore the aim is to supply the decision maker with information that can clarify particular problems and to make informed choices. As much as possible processing could and should be done during the pre-disaster risk reduction phase so as to ensure effective and timely hazard specific mitigation, prevention and preparedness. The most important attributes of information processing are:

- Timeliness – the delivery of data and information in time to drive decision-making;
- Consistency – delivery of data and information in a consistent and uniform manner;
- Understandability – delivery of data and information in a manner that is appropriate and understandable in the target community;
- Accuracy - precision in measurement and observation; and
- Flexibility - adaptability to multiple situations.

- **Dissemination**

The final process in the cycle is the timely distribution of information to those who need it to make decisions. The inherent ability of modern distribution systems to present processed information in a variety of formats greatly assists the dissemination of information and also contributes to better understanding.

It is of no use to only know end user information needs, as these needs have to be satisfied and could, *inter alia*, be addressed via:

- Simple text descriptions – easily understood and uncomplicated verified facts;
- Levels of warning – brief explanation of the hazard, its progression, cautionary advice and status;
- Simple diagrams – locality maps, north point, scale, full key that is faxable or printable, preferably in black and white;
- Imagery – photographs, aerial photographs, and satellite imagery;
- Interpreted imagery as maps – reflecting pertinent items such as flood lines, lava flows and access/egress routes;
- Contact details – e-mail addresses, telephone/fax numbers of persons, services and installations;
- Registering for automatic updates – via telephone, e-mail and/or fax – in order to obtain latest developments;
- Meteorological data – updating on changing weather conditions;
- Hazard onset speed/rates – predictions on hazard movement/impact such as flood fronts and fire fronts in order to extrapolate events;
- Web links, addresses/phone/fax indicating “further information” which should include explanations as to value and information type;
- Information on other technology – web sites that refer to radio bulletins and vice versa; and
- Documents (downloadable, printable copy-able) publications covering warning notices, access maps and daily bulletins for display/distribution and personal accreditation/identity cards.

Functions

The information management system must be able to support all of the following functions:

- Hazard, vulnerability and risk analysis;
- Quantitative and qualitative research coordination;
- Data administration;
- Baseline data identification;
- Effective communication and secure data sharing;
- Monitor preparedness, mitigation and preventative planning and implementation;
- Volunteer administration;
- Operate an early warning network;
- Early warning evaluation;
- Event mapping;
- Emergency response and specific tasking (activation);

- Resource deployment and monitoring;
- Monitor and evaluate:
  - Response;
  - Rehabilitation;
  - Reconstruction;
- Executive Briefings;
- Control documentation – Standard Operating Procedures (SOPs), protocols, reports, framework for strategic decision taking, job descriptions, checklists etc.; and
- Identification of gaps in information.

▪ Information and Geographical Information System

As a proactive measure to prepare for event response, a geographical information management system must be utilized to enter crucial data to provide a base map for change detection, probable damage assessment, and the presentation of scientific verifiable impacts.

GIS can, for risk assessment purposes, be applied as follows:

- Hazard mapping. A very common use of GIS in risk assessment is the preparation of hazard maps e.g. for cities, regions or an entire country and large tracts of space. Hazard maps serve as risk zone identifiers, are easy to understand and are of great help to planners and developers, since they serve as a quick identifier for risk prone areas;
- Threat maps. The purpose of threat maps is to quickly communicate the risks to people and can be overlapped with population and land use maps to arrive at meaningful conclusions. These maps could be supplied to the media for effective warning communication;
- Government planning for Climate Change Response. It is well known that regional planners require sophisticated risk assessment tools. GIS can not only reflect spatial and non-spatial data, but can also contain built-in risk assessment programmes that allow planners and Climate Change functionaries to simulate scenarios and graphically view the potential damages and affected areas as well as plan rescue operations.

▪ Community Information Needs

The Municipality must make sure that community information needs will:

- Increase resilience to climate change in their specific environment;
- Address social, cognitive and organizational needs during the different phases of adaptation and respond to climate change impacts;
- Support the changing roles of individuals and organizations, as there is a need to adapt to shifting needs without compromising established guidelines.

The Municipality must provide information to communities in a form that will allow them to make their own decisions. Relevant municipal staff needs the knowledge, skills and attitudes to enable them to work *with* communities rather than just for them. This statement implies a partnership between the municipality manager and the different communities in his/her area of responsibility.

5.13 Financing Climate Change Response

While considerable parts of climate change response will not require new investments but rather a more climate-aware investment of existing resources, the cost of transition to a climate resilient society could be significant. The provision of funding for Climate Change initiatives is likely to constitute the single most important factor contributing to the successful implementation of comprehensive climate change adaptation in national, provincial and municipal spheres of government. Therefore it will be important to establish adequate climate change financing strategies.

Emerging climate change response funding options for local government includes grants for research and development co-operation, finance through debt and equity, concessionary finance, risk insurance, specialized environmental funds, and new capital markets such as green and climate bonds.[124]

The National Climate Change Response White Paper (2011) addresses the issue for resource mobilization and acknowledges the need to improve efforts to create, allocate and mobilize finance for climate change mitigation and adaptation. However, a national funding framework for mitigation and adaptation must still be developed.

[124] Western Cape Government. 2014. Western Cape Climate Change Response Strategy

Current Climate Finance Issues

- Bilateral funds and Bilateral Finance Institutions (BFIs) focus more on mitigation as adaptation is costly.
- The views on climate finance differ greatly between developing and developed countries. Developing countries believe that they are entitled to climate funding because developed countries are responsible for past carbon emissions.
- Although there are numerous benefits of monitoring, reporting and verifying of climate finance (MRV) (building trust between developing and developed countries, sharing of best practice, building capacity, monitoring progress and encourages the implementation of climate policies) there are many issues that prevent successful MRVs for example additionality, inconsistency and scarce information.
- Developing countries would like to reform institutions like the World Bank or replace them with new institutions in order to restructure the decision making-power to be in their favour.

Table 20: Selected funds application and eligibility conditions (Source: Synthesis of Climate Finance, DEA: 2011)

Fund and implementing organisation	Application, eligibility and administration
Global Environment Facility – Multilateral Development Banks and United Nations agencies	Available to countries who are eligible to borrow from the World Bank or countries who are eligible to receive United Nations Development Programme technical assistance. The eligibility criteria for concessional financing (a form of financing other than grants) is determined by the Conference of the Parties and the Global Environmental Facility Council.
Adaptation Fund – National Implementing Entities, Multilateral Development Banks and United Nations agencies	Eligibility for funding is determined through seven criteria that include issues of vulnerability, design and implementation, benefits and adaptive capacity. Countries can access funds directly through accredited National Implementing Entities.
Least Developed Countries Fund - Global Environment Facility	Eligible countries are those that have been classified as Least Developed Countries that have completed their National Adaptation Programmes of Action (NAPA). Funding is available for specific projects within the National Adaptation Programmes of Action that have been developed in accordance with the general NAPA rules concerning stakeholder consultations, financing plans and monitoring and evaluation.
Special Climate Change Fund - Global Environment Facility	Funds are only available for projects that are additional to 'baseline' development activities. For eligibility, the applicant has to be able to demonstrate that the 'additionally' is a consequence of the effects of climate change.
Clean Technology Fund – World Bank (Trustee), Multilateral Development Banks	Funding is available to countries who are eligible for Official Development Assistance as well as countries that actively engage with Multilateral Development Banks for development purposes (where the MDBs assess the potential for investment in a particular country).
Strategic Climate Fund – World Bank (Trustee), Multilateral Development Banks	The Strategic Climate Fund Committee is responsible for determining how the funds are used and the funding eligibility criteria. This decision-making is guided by the principles of the United Nations Framework Convention on Climate Change.

Millennium Development Goal Achievement Fund – United Nations Development Programme	Funding is available for projects that are developed in at least two United Nations agencies in partnership with national government and non-governmental peers. To be eligible, a United Nations Resident Co-ordinator is required to oversee the programme that will potentially receive the funding.

Climate Finance Best Practice

- Best practice increases the climate finance that South Africa attracts thus creating a favourable investment environment for public and private financing internationally and domestically.
- Policies that aim to reduce GHG emissions must be put in place, institutional capacity must be strengthened and risk must be reduced (balancing the risk-reward scale) in order to enhance investment in projects regarding climate change.
- Evidence shows that it will eventually be too costly to invest in projects that do not take climate change into consideration thus climate change should be considered in all decision-making.

South African Context

- The National Climate Change Response Green Paper briefly discusses climate financing provision goals but other official documents such as the Second National Communication under the UNFCCC pay very little attention to climate financing.
- The range of available climate funding sources in South Africa (Table 2) is increasing.
- There is no overarching framework ensuring that climate finance is used to fund South Africa's climate change priorities thus it is unlikely that climate finance in South Africa will be used efficiently.

Table 21: Selected sources of local climate finance

Source of funding	Examples
Public sector and Development Finance Institutions funding	R1 billion was allocated to a green fund in the 2011/2012 budget. The Industrial Development Corporation allocated R25 billion to green industries between 2011/2012-2015/2016.
Donor funding	The National Treasury allocates the funds to certain departments.
Carbon markets	Although carbon tax may increase mitigation, emissions trading is not the most appropriate domestic policy in South Africa due to structural issues in the economy.
Private sector funding	Private equity funds available for climate finance is approximately R3-5 billion.
Additional sources of funding	The Renewable Energy Finance and Subsidy Office (REFSO), The South African National Energy Development Institute (SANEDI), The Renewable Energy Feed-In Tariffs (REFIT), Renewable Energy Market Transformation project, Central Energy Fund (CEF)
Innovative financing structures	The Clinton Climate Change Initiative, The South African Renewables Initiative (SARi), pension fund regulations

6 Implementation

6.1 Policy commitment

The UGU DM supports the idea that integrated planning at all levels of government should include the consideration of climate change aspects in relevant sectors.

The UGU DM is also of the opinion that the mitigation of- and adaptation to climate change will require standalone mitigation and adaptation policies and plans as well as the mainstreaming of adaptation measures into the existing activities and functions of national, provincial and local government. The mainstreaming of climate change response implies that local government adopt, expand and enhance the measures that factor climate risk into their normal day-to-day activities and planning processes.

The strategic priorities of the UGU DM are to:

1. To provide access to sustainable quality drinking water and sanitation services;
2. To create a conducive environment for economic growth and job opportunities;
3. To develop and maintain a financially viable and sustainable organization that achieves full compliance with legislation;
4. To build and strengthen the administrative and institutional capability of the municipality;
5. To develop and promote an integrated sustainable environment; and
6. To create a conducive environment for participatory development.

As discussed in previous chapters, the threats of unanticipated climate change impacts are real, and can jeopardize the ability of the UGU DM to meet its strategic objectives in the following ways:

- The environmental integrity of the District can be disrupted;
- Economic growth can be stunted and job opportunities reduced;
- Social wellbeing can be threatened and replaced by increased vulnerability;
- The need for services and maintenance can rapidly increase, shift or decline depending on climate change impacts; and
- The financial viability of the district as a whole can be threatened.

The UGU DM therefore commits itself to effective and integrated pro-active day-to-day climate change response inclusive of monitoring, mitigation and adaptation, thereby reducing environmental degradation and socio-economic vulnerability while building resilience against climate variability.

The implementation framework is supplemented with a detail Climate Change Response Action Plan outlined in Annexure B. The goal of the action plan is to support efforts towards implementation of the UGU DM Climate Change Strategy.

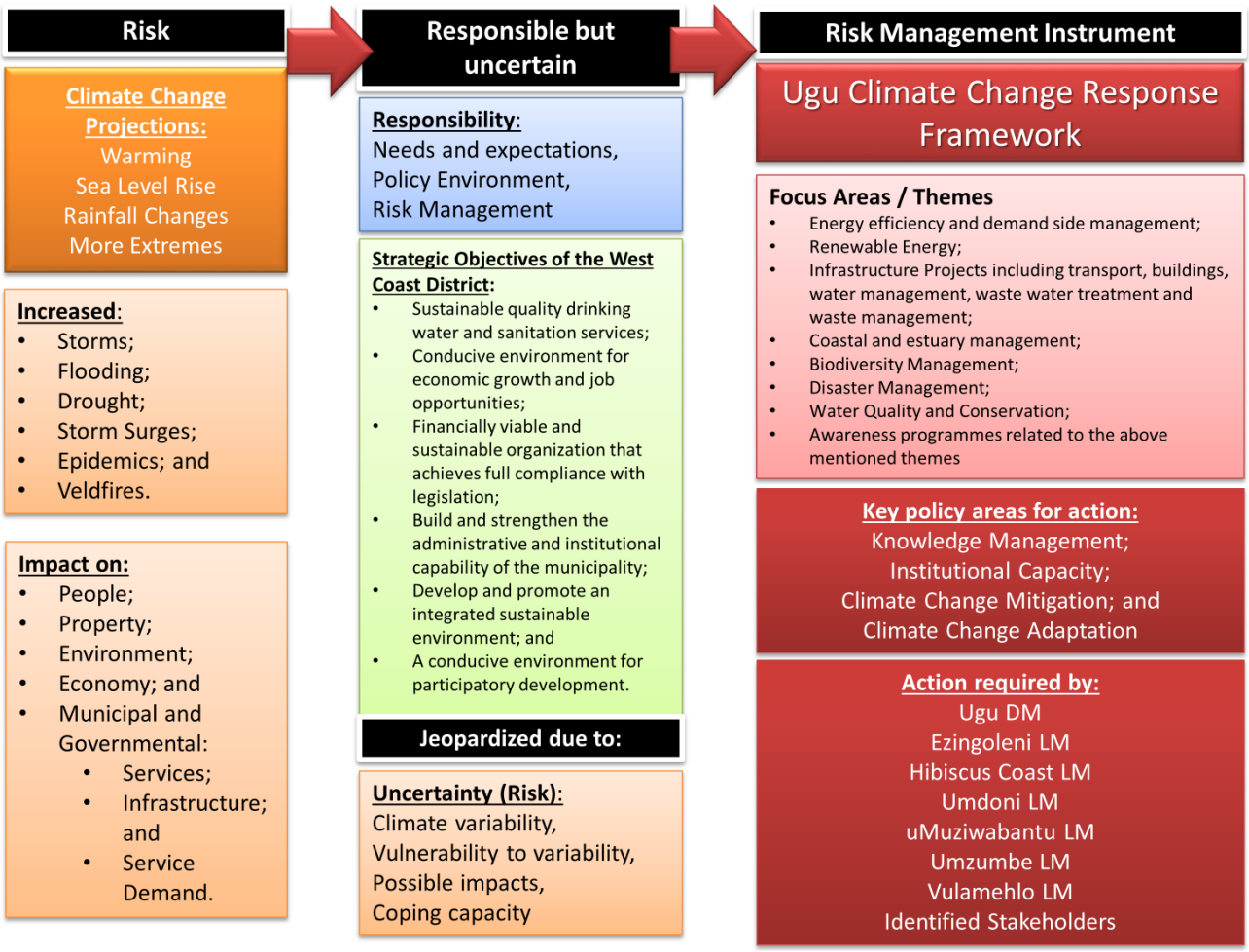


Figure 78: Climate change risk, responsibility and a response framework

6.2 Purpose

The Ugu District Municipality Climate Change Response Implementation Framework aims to direct, facilitate and coordinate successful climate change response (mitigation and adaptation) and the long-term sustainability of the UGU DM, in alignment with climate change policy and initiatives in the Western Cape Province and in South Africa.

6.3 Objectives

The objectives of the UGU DM Climate Change Response Implementation Framework are to:

- Build resilience and reduce vulnerability to climate change impacts;
- Guide the evaluation of infrastructure design guidelines and considerations to expected hazard profiles linked to climate change;
- Provide policy support to climate change mitigation and adaptation initiatives within the UGU DM; and
- Clarify roles, responsibilities and organisational opportunities in climate change mitigation and adaptation.

6.4 Key Implementation Actions

The Ugu District Municipality Climate Change Response Implementation Framework includes key implementation actions that are discussed in the rest of this section. These suggested implementation actions are aligned to the UGU DM Climate Change Response Strategy and its focus areas, but are condensed in the following four overarching policy areas:

- Knowledge Management;
- Institutional Capacity;
- Climate Change Adaptation; and
- Climate Change Mitigation.

The listed implementation actions are policy recommendations that can be considered for implementation as distinct projects by the UGU DM and the local municipalities within the district or even by other identified stakeholders with appropriate mandates.

The suggested implementation actions are summarised in the graphic below and then detailed in subsequent paragraphs.

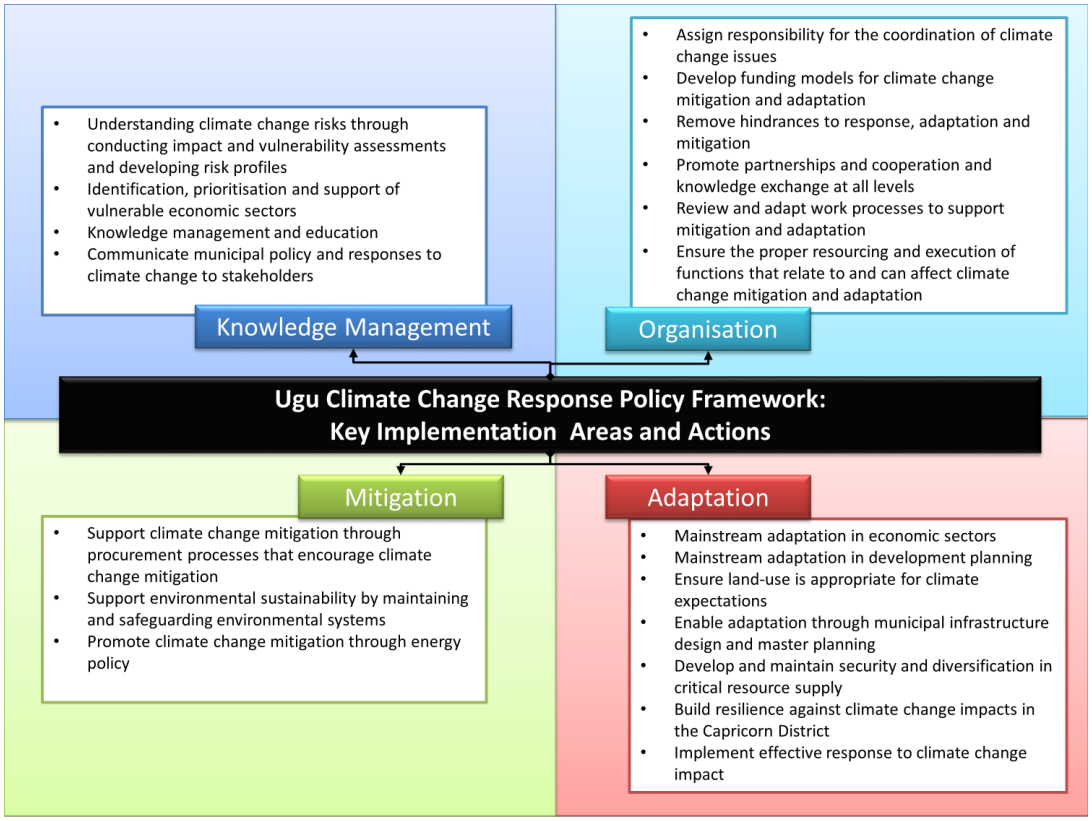


Figure 79: Summary of the framework's key implementation areas and actions

6.5 Knowledge management for climate change mitigation and adaptation

Develop, maintain and share knowledge on climate change in the Ugu District.

6.5.1 Understanding climate change risk

Understanding climate change risks through conducting impact and vulnerability assessments and developing risk profiles:

- Identify local climate change projections, challenges, impacts, vulnerabilities;
- Evaluate existing mitigation and adaptation plans;
- Identify existing capacities and resources;
- Develop climate change objectives for inclusion in the IDP;
- Maintain ongoing risk monitoring;
- Determine and map climate-related hazard impact zones such as:
  - 1/100 year flood lines;
  - Low-lying areas prone to flooding in extreme events;
  - Areas vulnerable to erosion; and
  - Areas vulnerable to salt-water intrusion into groundwater;
- Utilise the public awareness and education benefits of risk assessments to build awareness;
- Maintain a linkage and sharing of information between climate change risk assessments and disaster risk assessments;
- Consider at least the basic contributing variables of disaster risk, being Hazard (likelihood, impact) X Vulnerability (exposure) / Capacity (resilience) during climate change risk assessments; and

- Conduct specialist studies to further clarify climate change impact projections, and to identify and evaluate the potential and/or real benefit of mitigation and adaptation actions.

6.5.2 Identification, prioritization and support of vulnerable economic sectors

Economic development and socio-economic support should be sensitive to those economic sectors that are most vulnerable to climate change impacts and should prioritise adaptation support to these sectors while consistently advocating climate change mitigation and adaptation; and

Local economic development decisions should be risk-based and should consider climate change mitigation and adaptation.

6.5.3 Knowledge management and education

- Collect, manage and share climate change information throughout the District;
- Develop a central climate change risk, mitigation and adaptation information repository within the District and actively share and make available the information collected;
- Participate in forums where climate change information is developed, shared and discussed;
- Build the awareness of municipal workers regarding climate change and how they can contribute to mitigation and adaptation;
- Build public and stakeholder awareness regarding:
  - Climate change risk;
  - Climate change and energy:
    - Energy efficiency and demand side management; and
    - Renewable Energy;
  - Relationships between climate change and infrastructure projects including:
    - Transport;
    - Buildings;
    - Water management;
    - Waste water treatment; and
    - Waste management.
    - Climate change and environmental conservation:
    - Coastal and estuary management;
    - Biodiversity management; and
    - Water quality and conservation;
  - Climate change and disaster management; and
    - The organization and coordination of climate change mitigation and adaptation.
- In order to build an information base on climate change indicators, develop and maintain ongoing monitoring of:
  - Stream flow;
  - Precipitation;
  - Temperatures;
  - Wind;
  - Roads and transport infrastructure;
  - Infrastructure and equipment maintenance intervals; and
  - Supply and use of resources such as water, energy and food.

6.5.4 Communicate municipal policy and responses to climate change to stakeholders

6.6 Organize for climate change mitigation and adaptation

Develop and maintain institutional capacity to mitigate and adapt to climate change in the Ugu District.

6.6.1 Assign responsibility

Assign responsibility for the coordination of climate change issues at a strategic level within a municipality, bearing in mind that each department has a role to play in climate change mitigation and/or adaptation. The responsibility for climate change mitigation and adaptation could be assigned to the person responsible for the IDP or Town Planning or Environmental Management.

6.6.2 Develop funding models

Develop funding models for climate change mitigation and adaptation:

- Develop cost-benefit models for climate change mitigation and adaptation at local municipal and district level to illustrate the value that can be unlocked by funding climate change response;
- Ensure that each business unit within municipalities consider investing in climate change response within their normal operational and capital budgeting, not by spending on new projects but by spending on existing projects in a way that supports climate change response; and
- Assign responsibility to a nodal point within the district to seek and pursue external funding or other assistance for climate change response initiatives within the district.

6.6.3 Remove hindrances

Remove hindrances to response, adaptation and mitigation:

- Advocate for the ability to trade water rights on a temporary basis during crisis situations in order to allow license holders who have lost crops due to flooding or drought to generate cash flow and restore production; and
- Develop local policy and technical capacity to allow for nett metering of electricity supply and the purchase of electricity from local private producers using renewable sources at lower rates.

6.6.4 Promote partnership

Promote partnerships and cooperation and knowledge exchange at all levels;

- Establish or joint provincial / regional / district partnerships aimed at climate change mitigation and adaptation;
- Facilitate coordination between different departments and sphere of government;
- Actively support and participate in climate change mitigation and adaptation forums, contributing to the effective functioning of such forums; and
- Develop and use links with research institutions to gain access to information and expertise as well as possible funded research project that can be conducted in the Ugu District.
- Review and adapt work processes to support mitigation and adaptation:
- Take land use decisions informed by climate change risk;
- Set basic development-approval conditions that supports and requires greening and sustainability of developments and thereby mitigation and climate change adaptation;
- Consider and prioritise sensitivities of infrastructure and services to increases in impacts from climate-change related hazards such as flooding, precipitation (or lack thereof), wind, fire and mean temperature in spatial planning and land-use decisions;
- Adapt design standards and planning for roads rail and other infrastructure to cope with climate change.
- Consider climate change mitigation and preparedness in operational decision-making;
- Adopt sustainable, renewable and green technologies where feasible and affordable in day-to-day operations;
- Monitor and increase efficiencies in resource use (e.g. water, energy); and
- Test work processes for compliance with environmental legislation and implement corrective actions where necessary.

6.6.5 Ensure proper resourcing

Ensure the proper resourcing (including financial and human resources) and execution of functions that relate to and can affect climate change mitigation and adaptation, including:

- Integrated development planning (infrastructure);
- Town and regional planning;
- Environmental health;
- Disaster management;
- Coastal and estuary management;
- Biodiversity management; and
- Water quality management and water conservation.

6.7 Climate change mitigation

Mitigate the climate change contribution of the Ugu District.

6.7.1 Support mitigation through procurement policy

Support climate change mitigation through procurement processes that encourage climate change mitigation:

- Review and where necessary amend procurement policies and procedures to promote climate change mitigation by considering the environmental footprint and climate change risk contribution as well as climate change impact resilience of service providers, services, products, materials, equipment and facilities;

- Consider the sustainability of technologies and materials, the manner in which service providers and suppliers of goods are committed to reducing their contribution to climate change, and the resilience of products against increased climate change impact in the choices between suppliers, equipment and supplies; and
- Develop pricing and remuneration mechanisms that support climate change mitigation, such as encouraging and rewarding the efficient use of energy and penalising wastage or over-consumption.

6.7.2 Support environmental sustainability

Support environmental sustainability by maintaining and safeguarding environmental systems:

- Align policy and organisational structures with environmental legislation to ensure that activities listed in environmental legislation are effectively controlled within the district.

6.7.3 Support mitigation through energy policy

Promote climate change mitigation through energy policy:

- Promote energy efficiency and demand side management (e.g. greening of buildings and managing time of use);
- Promote sustainable renewable energy projects and allow the integration of renewable energy into the energy service offering to municipal clients through independent power producers contributing to municipal power grids; and
- Advocate for access to affordable renewable energy through the national electricity provider linked to the hosting and support of renewable energy plants in the Ugu; and
- Understand sustainable energy options and potential impacts on municipal revenue during business and development planning.

6.8 Climate change adaptation

Lead and support climate change adaptation in the Ugu District through strategic risk reduction and improving resilience.

6.8.1 Mainstream adaptation in economic sectors

Mainstream adaptation in economic sectors:

- Adaptive agriculture – support the local agricultural sector in identifying and addressing climate change impacts, e.g. increased pest species, increased need for refrigeration, increased risk of hailstorms, collaborate with the Department of Agriculture's extension services of advocating sustainable land use practices and conservation agriculture; and
- Adaptive tourism – support the tourism industry that is dependent on biodiversity and natural resources in the early identification of any possible shifts in distribution of high-value species, with early adaptation in terms of land acquisition for natural heritage protection.

6.8.2 Mainstream adaptation in development planning

Mainstream adaptation in development planning:

- Develop and approve a climate change responsive IDP to ensure integration of climate change adaptation into sectoral planning;
- Identify institutional structures and champions that can drive and co-ordinate climate change adaptation within specific settings;
- Develop climate change adaptation integration process plans and timelines for all business units within municipalities;
- Establish a climate change committee/forum that includes development planning specialists within each municipality, or alternatively add climate change adaptation considerations as a standing item on municipal development planning meetings;
- Add climate change adaptation considerations as a standard step in the development approval process within municipalities;
- Advocate for pro-active adaptation to anticipated climate change impacts;
- Integrate climate change information into transport planning, in order to minimise the potential risk to infrastructure from extreme weather events
- Reprioritise existing projects based on climate change mitigation and/or adaptation potential; and
- Align and ensure cross-pollination between climate change adaptation within the district and local municipalities with the Ugu Spatial Development Framework (SDF), IDP, and Disaster Management Plan (DMP).

6.8.3 Ensure land-use is appropriate for climate expectations

Ensure land-use is appropriate for climate expectations:

- Consider climate expectations and natural variability in decisions on land-use change, modification or variability; and
- Coordinate with national department to encourage the co-use of low-yield agricultural land for renewable energy installations to diversify the income streams of agriculture and broaden the tax base

6.8.4 Adaptation through infrastructure design and master planning

Enable adaptation through municipal infrastructure design and master planning:

- Ensure that municipal departments responsible for infrastructure construction, operation and maintenance conduct infrastructure master planning based on expected climate change impact for among others transport, buildings, water management, waste water treatment and waste management; and
- Ensure that municipal departments responsible for infrastructure construction test the sensitivity of current and planned infrastructure to expected climate change impacts and review operating and design standards. Where necessary adding additional safety factors aligned with climate prediction, e.g. an additional safety factor for storm water design or adapting pavement design to higher expected ambient temperatures;
- Encourage the integration of land use and transportation planning in cities in a manner that encourages public transport, non-motorised transport (walking and cycling) and promotes alternative communication methods such as tele-commuting, in order to reduce long term transport fuel use patterns.
- Encourage the integration of land use and transportation planning in cities in a manner that encourages public transport, non-motorised transport (walking and cycling) and promotes alternative communication methods such as tele-commuting, in order to reduce long term transport fuel use patterns;

6.8.5 Develop and maintain security and diversification in critical resource supply

Develop and maintain security and diversification in critical resource supply. In order to reduce vulnerability and reliance on single points of failure in resource supply, the district should plan to build out the diversity of:

- Energy supply;
- Water supply;
- Agriculture; and
- Food Security / Food Sovereignty.

6.8.6 Build resilience against climate change impacts

Build resilience against climate change impacts in the Ugu District:

- Consider and ensure the availability of alternatives when climate change impacts such as increased flooding denies access to or damages infrastructure, essential supplies and services inclusive of water, energy, food and access roads;
- Conduct detailed preparedness and response planning as well as drills and exercises for worst-case or extreme scenarios;
- Review and update district and local municipal disaster management plans annually;
- Ensure a high level of preparedness for known and regularly experienced natural hazard impacts, thereby building capacity to deal with more severe natural hazard impacts resulting from climate change;
- Ensure the continuity of lifeline services and resources; and
- Link groundwater extraction points to the sources of groundwater and research sources and threats that may affect future use.

6.8.7 Implement effective response to climate change impact

Implement effective response to climate change impact:

- Promote adaptation for vulnerable communities and sustainable local economic development;
- Prioritise the role of functioning ecosystems as core for municipal green infrastructure;
- Identify and implement no-regret interventions in climate change impact response, ensuring that response to climate change impacts will support future climate change mitigation and adaptation;
- Develop short-term investments in adaptation with visible benefits that incrementally contribute towards long-term investment and support sustainable adaptation;
- Develop key performance indicators for municipal departments that relate to climate change adaptation; and

- Avoid dead-ends – Consider future flexibility in all investment decisions responding to climate change impact, asking whether a particular investment could prevent or obstruct further adaptation in future.

6.9 Community and traditional engagement

6.9.1 Current challenges

Traditional leaders form an essential part of the governance system. Their work is to "continuously work with them for development of rural communities."[125] Ugu District Municipality has 28 traditional authorities[126] who main tasks include allocating land as well as managing the communal land and natural resources in the area. Moreover, because the legitimacy of the traditional leaders is rooted in culture, tradition and religion, rather than the law, they tend to have a significant influence on their subjects and act as spokespeople for their communities. Considering that the traditional leaders have authority over the most vulnerable groups of people to climate change and manage land that is also incredibly sensitive to the climate change, it is important that they be part of the municipality's adaptation strategy.

The roles and responsibilities in collaborative governance between local government and traditional authorities however does experience some challenges

- The role, functions and power of the traditional authorities are unclear. Although the 'Traditional Leadership and Governance Framework Act of 2005' and the 'White Paper on Traditional Leadership and Governance (2003)' try to determine the roles that traditional authorities should assume in their communities, the functions of traditional authorities are ill-defined[127], make no mention of how they can collaborate with local government and generally lack an implementation strategy. With no clear functions for traditional leaders, there is tension between local government and traditional leaders due to, sometimes, overlapping functions. Traditional leaders may feel insecure in their positions because they are not as secured and defined as the roles and functions of ward councillors. Moreover, the ambiguous functions of traditional leaders may make it difficult for the local municipality to include the traditional leaders in the adaptation strategy. The lack of a clear and differentiated role for traditional authorities and local authorities creates a power struggle that makes it difficult for the two parties to work together. At a commonwealth local government forum, participants agreed that traditional leaders need to play an active role in government but that the nature of this role requires serious debate[128]. Optimum functioning of the traditional leaders is hindered, mostly, by uncertainty.
- There is no relationship (or limited trust) between the local government authorities and the traditional authorities: Buthelezi (2011)[129] highlights this challenge within KZN where local government does not make a real attempt at working with the traditional leaders. He complains that the traditional leaders are only consulted once the draft documentation has been compiled and the suggestions from the traditional leaders can no longer be incorporated. Traditional leadership is therefore seen, by local government officials, as something of the past that has no role to play in the modern, democratic South Africa. Sometimes, traditional societies may even be seen as backwards while the legal, constitutional local government is seen as somewhat superior to traditional leadership. However, traditional leaders still have a great amount of influence in their communities. The challenge here is that the local municipalities do not make an effort to build a strong partnership with the traditional authorities (don't attend Imbizos/are not invited to the Imbizos, do not take traditions into consideration, bypass the chiefs in decision-making) and the traditional authorities may not allow enough flexibility in culture that is needed to keep up with the post-Apartheid South Africa. This might also be worsened by the fact that there are no proper communication structures between the two parties, leaving traditional authorities feeling isolated.

[125] South African Government, Official opening of the Ugu House of Traditional Leaders. Available online at http://www.gov.za/official-opening-Ugu-house-traditional-leaders

[126] Ugu District Municipality, Traditional Leaders. Available online at http://www.Ugu DM.org.za/index.php/2014-06-24-13-34-25/traditional-leaders

[127] The White Paper repeatedly states that traditional leaders shall "play a role" in different areas of local governance but does not actually define what this role is or should be.
Ministry for Provincial and Local Governance. 2002. *White Paper on Traditional Leadership and Governance*. Pretoria: Department of Provincial and Local Governance. Available from: http://us-cdn.creamermedia.co.za/assets/articles/attachments/00781_whitepapertradleadgov.pdf

[128] Common Wealth Local Government Forum, Gaborone, Botswana. 23 – 26 September 1997.

[129] Buthelezi, M. 2011. Traditional leaders have an important role to play. *Politics Web.* Available from: http://www.politicsweb.co.za/party/traditional-leaders-have-important-role-to-play--b.

- There are (perceived) conflicting priorities and values between the District Municipality and the traditional authorities[130]: There is still a tendency, in South Africa, to think about climate change and development in a binary and mutually exclusive way (owing, particularly, to the way that climate change is packaged and presented to civil society). Climate change is seen as something far removed from the reality of poor South Africans while poverty and hunger seem to be of greater importance. Some traditional authorities may see conservation and development as trade-offs. Moreover, traditional authorities aim to keep the traditions and culture intact, whereas the local government's focus is advancing the modern, democratic South Africa. There may be instances in which the local government and the traditional authorities clash over how best to approach the betterment of their communities even though they both seek to improve the communities in the end.

6.9.2 Addressing shortcomings

Progressing toward integrated aligned developmental collaboration between traditional leaders and local government will have significant benefits to climate change adaptation and mitigation strategies specifically but also to sustainable development practices in general.

- In partnership with the traditional authorities in the area, it is important to spell out the roles and functions that traditional authorities are expected to play in climate change adaptation, and to clearly differentiate the roles from those of the local government to avoid overlap in functions and duties and to ensure accountability.
    - The starting point for defining the roles that traditional leaders will play could be mainstreaming climate change adaptation into some of the tasks traditional leaders already perform (i.e.: land allocation, serving as advisors on environmental matters that affect traditional custom).
    - On a national government or provincial government level, it may be necessary to establish a particular relationship of power between government officials and traditional authorities. The power struggle between the two requires that there be a higher/final authority or a conflict resolution mechanism. Once again, this has to be done in *partnership* with traditional authority councils. Both the local government and traditional authorities have to be willing to concede some power.
- Both local government and traditional authorities should take the steps that are needed to build a relationship of tolerance, partnership and trust.
    - Develop a programme that aims to improve the relationship between ward councillors and traditional authorities (a teambuilding programme) with a regular review mechanism.
    - The District needs to start involving traditional authorities in climate change adaptation dialogues and workshops. The local government should take a genuine interest in the concerns and traditions of these communities and their leaders by involving the traditional authorities from the outset and throughout the entire adaptation strategy process. Moreover, there should be more focus on dialogues instead of workshops so that the direction of the District Municipality isn't imposed on the traditional leaders but produced in *partnership* with the authorities. Communities are more likely to accept and comply with decisions that they feel they have ownership over. Involvement throughout the process will help traditional leaders realise that adaptation goes hand in hand with development and that the two are not mutually exclusive. The relationship between traditional authorities and local government should be one of partnership and dialogue where the authority of the traditional leaders is accepted as legitimate.
    - Training for traditional leaders should be focused on building their capacity to meaningfully participate in all government and leadership structures. Capacity building should be focused in the areas of:
        (a) Integrated Development Planning processes
        (b) Climate Change adaptation strategies
        (c) Budgetary planning
    - Training for local government authorities should be focused on tolerance building through learning about the different traditional customs of the communities that they will be working with.
    - It is important to observe and respect the customs of the traditional communities. Traditional customs affect how and why people engage with the impacts of climate change. In order to gain insight into the communities that the local government serves and how to approach the traditional leaders on

[130] Jones, L. 2011. Social barriers to adaptation: Exploring implications and identifying options for adaptation policy across the SADC region in *Overcoming Barriers to Climate Change Adaptation Implementation in Southern Africa.* L. Masters & L. Duff (Eds). Pretoria: African Institute of South Africa. 41 – 58.

collaborative environmental governance, the local government will have to learn about and understand the community's beliefs and traditional customs.
    - Allow traditional leaders to participate as robustly as ward councillors/municipal authorities in council meetings. Instead of just being asked for their opinion on a particular matter, they should be allowed to participate in decision-making.
- Provide traditional authorities with support and formal recognition. A lot of government officials may bypass traditional authorities because they are seen as an authority that has no place in post-Apartheid South Africa. However, traditional leaders still hold massive influence over the communities they lead and thus have the potential to play a key role on the community level (i.e.: mobilising workers for Greenification projects). The authority will be more likely to co-operate with the local government if they have a sufficient resources (human resources, office space, and a budget for development) and are formally recognised by the District Municipality. To assume that traditional leaders are irrelevant is to ignore an important influencer in rural communities.
- Traditional authorities have to organise their structures such that they are transparent and are able to be held accountable. Increasing the resources that are available to the traditional leaders and the areas over which they preside means that they must be able to account for all development project spending.
- Traditional authorities should also include local government in traditional authorities. For example, every six months, the chiefs may hold meetings in their communities (Imbizo) and local government authorities should be invited and allowed to participate as traditional authorities would participate in the local government council meetings.

6.10 Linkage with the IDP of the Ugu District

The Systems Act defines the Integrated Development Plan to be the single, inclusive and strategic plan "for the development of the municipality".
The Climate Change Response Strategy should become one of the criteria for a credible IDP document. Thus, climate change response is being elevated from the periphery of planning into the core of determining allocation of resources. To ensure success the Climate Change Response process involves:

- In the first phase of the Climate Change Response process, as in the IDP process, communities and stakeholders are given the chance to indicate/highlight the problems they experience and to determine their priorities (community based risk assessment), with inputs from relevant departments.
- The risks are addressed by technical task teams, will have to make recommendations on the most appropriate way(s) to address the risks, as well as, to ensure that project proposals are designed, which can be implemented.
- The Municipality, especially the IDP Manager and the head of DPEMS, has to make sure that the climate change response project proposals are in line with the objectives and the agreed strategies of the IDP of the Council.

6.10.1 Linkage with the Spatial Development Framework of the Ugu District

A Spatial Development Framework (SDF) is a prerequisite in terms of the Local Government Municipal Systems Act, 2000 (Act 32 of 2000) and a core component of an Integrated Development Plan and "must include the provision of basic guidelines for a land-use management system for the municipality".
An SDF is established by the municipality for implementation within the district by all role-players.
An SDF should be environmentally informed and sustainability-based, incorporating pro-poor policies rather than only being a spatial indication of IDP proposals. The collectives of the social, political, economic and environmental elements that underpin present-day society are regarded as fundamental informants to an SDF in order for spatial planning to complement economic growth and development.
A District SDF is an intervention at a critical planning level to facilitate progressive connectivity between activities in lower and higher order planning domains. Furthermore it is to be a proposal of spatial guidelines to take effect within the municipal area in order to direct future spatial interventions as a result of growth, development and policy and to reduce developmental disparities.
The Integrated Development Plan (IDP) of the Ugu District Municipality would be the key informant of the formulation process of the SDF. The IDP must accommodate the visionary statement of the Council that needs to direct all activities of all role-players that perform activities within the municipal area.
The figure below illustrates the context of the Regional SDF in relation to other regional processes and subsequent products, but also with regard to the cyclical nature of the development agenda.

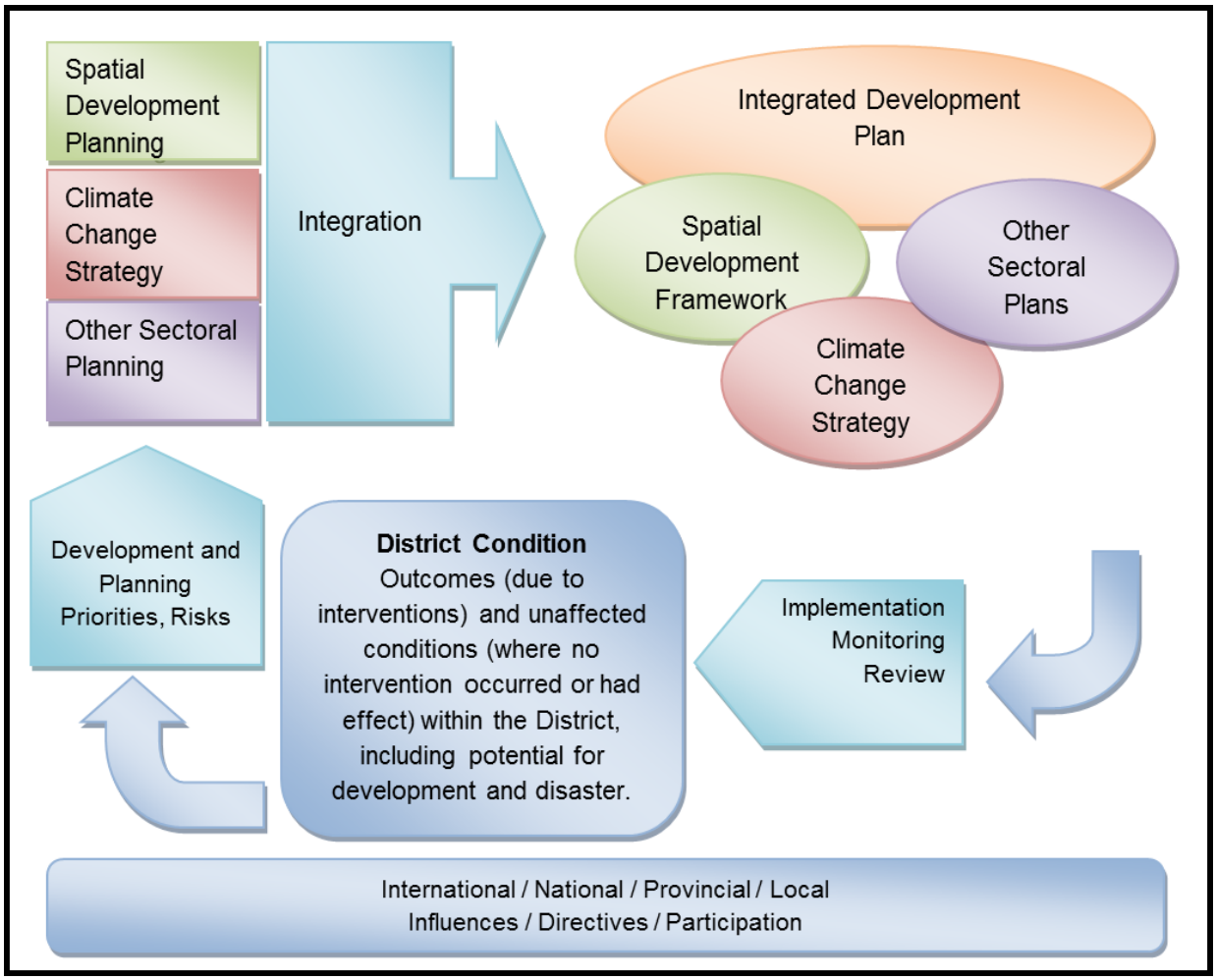


Figure 80: The relationship between the SDF, IDP and Climate Change Response Strategy

6.10.2 The relationship between climate change and development

It can be said that climate changes and development have both a negative and positive relationship, and this relationship needs to be recognised and managed to achieve sustainable development.

In a negative sense, climate change can compromise development and uncontrolled, improper development can increase risk. In a positive sense, climate change can create an opportunity for improved, more resilient development, and proper development can reduce the risk of disasters occurring.

Badly planned development in a floodplain increases disaster risk by making the new community vulnerable to flooding and thus disaster. The development of well-planned and effective flood defence measures can decrease the vulnerability of the community and thus contribute to disaster risk reduction. If a disaster actually occurs and major flooding impacts on the community, the development can be damaged or destroyed. If the lessons learnt from the flooding event are however incorporated in developing a new community outside the flood plain or if flood risk reduction is incorporated into the planning of a new community in the same setting, but this time from the outset, disaster risk reduction can also be achieved.

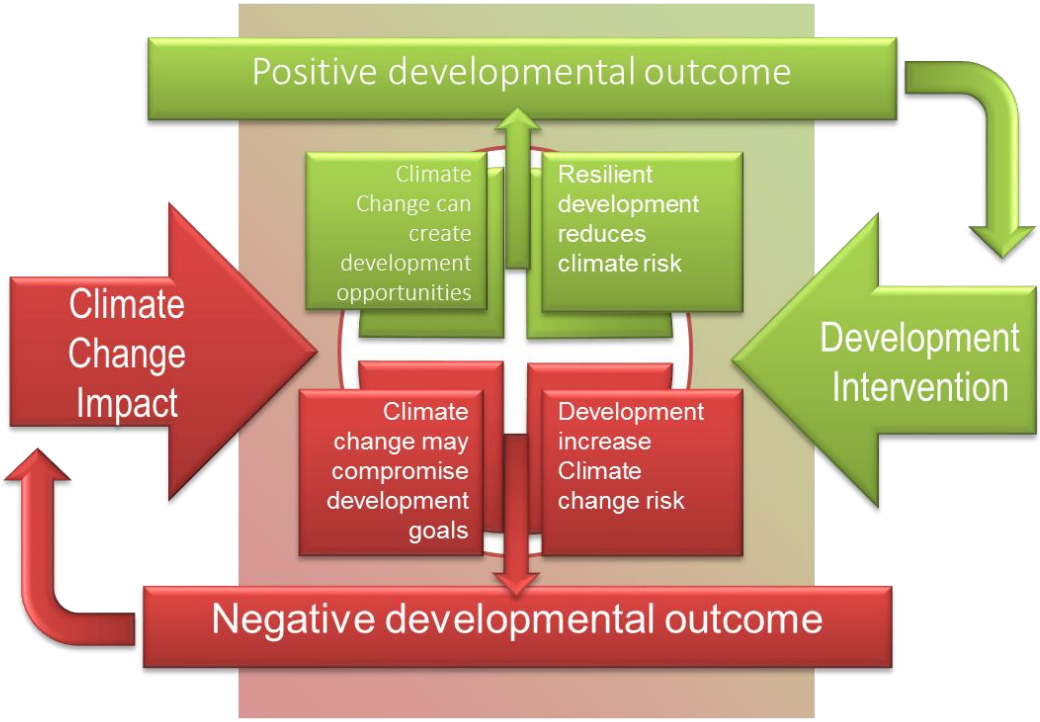


Figure 81: The relationship between climate change and development

6.10.3 Integrating development and climate change response

Based on the previous discussions of the relationship between climate change, the spatial development framework and the IDP, it is clear that the process for developing a Climate Change Response Strategy should be integrated with the IDP process.

Such a process is shown below. **Figure 82** illustrates the planning process for the development of municipal Climate Change Response Strategy as well as the integration of such plans into the integrated development plan of a municipality.

While a synchronization of the Climate Change Response process was not possible for this project, it is recommended that long-term planning for future IDP cycles should include the Climate Change Response Strategy steps indicated below.

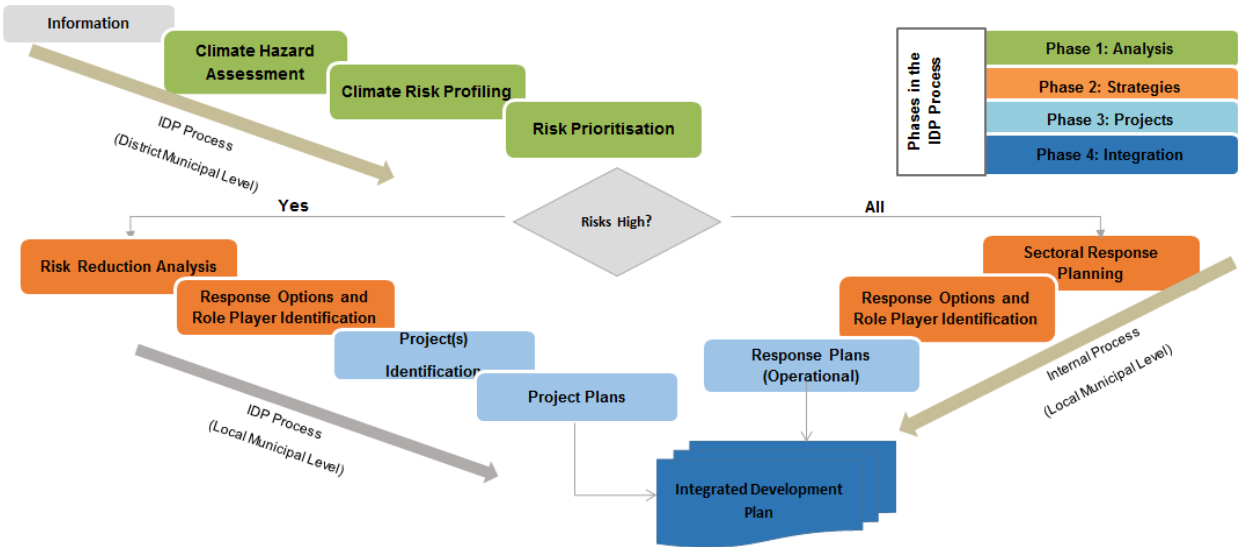


Figure 82: Planning Process for developing a DMP

6.11 Monitoring and Evaluation

Climate change response requires continuous monitoring and regular review in order to ensure efficacy. Successful implementation relies heavily on sustained and effective monitoring and evaluation of its effectiveness. The monitoring and evaluation process is supported by the indicators identified in the action plan to measure progress. Through the effective monitoring and evaluation of the District's climate change response the UGU DM looks to:

1. Measure to what extent adaptation efforts have been effective in a changing climate;
2. Monitor climate change mitigation actions and low-carbon development policies;
3. Generate evidence and lessons as a basis for future policy development;
4. Facilitate the coherent integration of M&E of climate change into development planning
5. Provide the information required to fulfil the reporting obligations towards funders and development partners.

Based on the Nation Climate Change Response Monitoring and Evaluation Framework, the UGU DM will have to implement the following principles in order to accurately monitor the success of the climate change response and measure cost, outcome and impact:

Mitigation

- A GHG Inventory;
- M&E System to support the analysis of the impact of mitigation measures;
- M&E system will assess indicators defined in action plan, including impact on emissions, implementation & wider sustainable development benefits;

Adaptation & Impact

- Establish a system for gathering information and reporting progress on the implementation of adaptation actions;
- Educate and build capacity of the institutions that must implement responses.

Climate Finance

- Establish a tracking facility for climate finance mechanisms and climate responses;
- Track the use and impact of funds.

The following template can be implemented to guide the monitoring and evaluation framework, supplemented by the departmental reporting template provided in Annexure C.

	INDICATOR What indicator will be used?	DESCRIPTION How will it be measured?	**TARGET** What are the determined target values?	**DATA SOURCE** Where will data for measurement be sourced from?	**FREQUENCY** How often will it be measured?	RESPONSIBILITY Who is responsible for reporting?	**REPORTING** Where will it be reported and how will it be used?
Objective							
Outcomes							
Outputs							

7 Conclusion

While this Strategy attempts to develop a process that will be applicable to all local municipalities in the Ugu District, municipal planning remains a complex process involving difficult decisions. The lengthy timeframes associated with climate change will also complicate matters, since they contradict the time frames attached to development planning, budgetary cycles and political office.

Local government is often caught in a continuous struggle to cope with day to day service delivery problems. Limited institutional capacity and financial resources will require municipalities to align their climate change objectives with their everyday commitments rather than developing a separate approach.

The climate change impacts experienced across the UGU DM will vary among the district's communities and will be influenced by various factors. The lack of uniformity regarding the experience of climate change impacts emphasises the need for the inclusion of multiple perspectives into the municipal planning process.

Climate change poses a real threat to the UGU DM and the local municipalities situated within the district and needs to be addressed through effective and strategic climate change response measures.

The project has set out to establish a baseline of information on climate change risk within the district and the institutional capacity to deal with such risk in terms of mitigation and adaptation, and then to develop strategy guide the UGU DM's journey towards climate resilience.

The UGU DM and the local municipalities situated within the district should actively utilise this strategic framework and endeavour to implement the recommendations contained herein using the implementation guideline provided as an addendum. A crucial first step in this regard would be for the assigning responsibility for the coordination of this framework and its recommendations to a specific position within the district.

The successful implementation of the Strategy will reinforce sustainable development goals and make a real contribution to the resilience of the district and its people in general and against climate change.

8 Appendixes

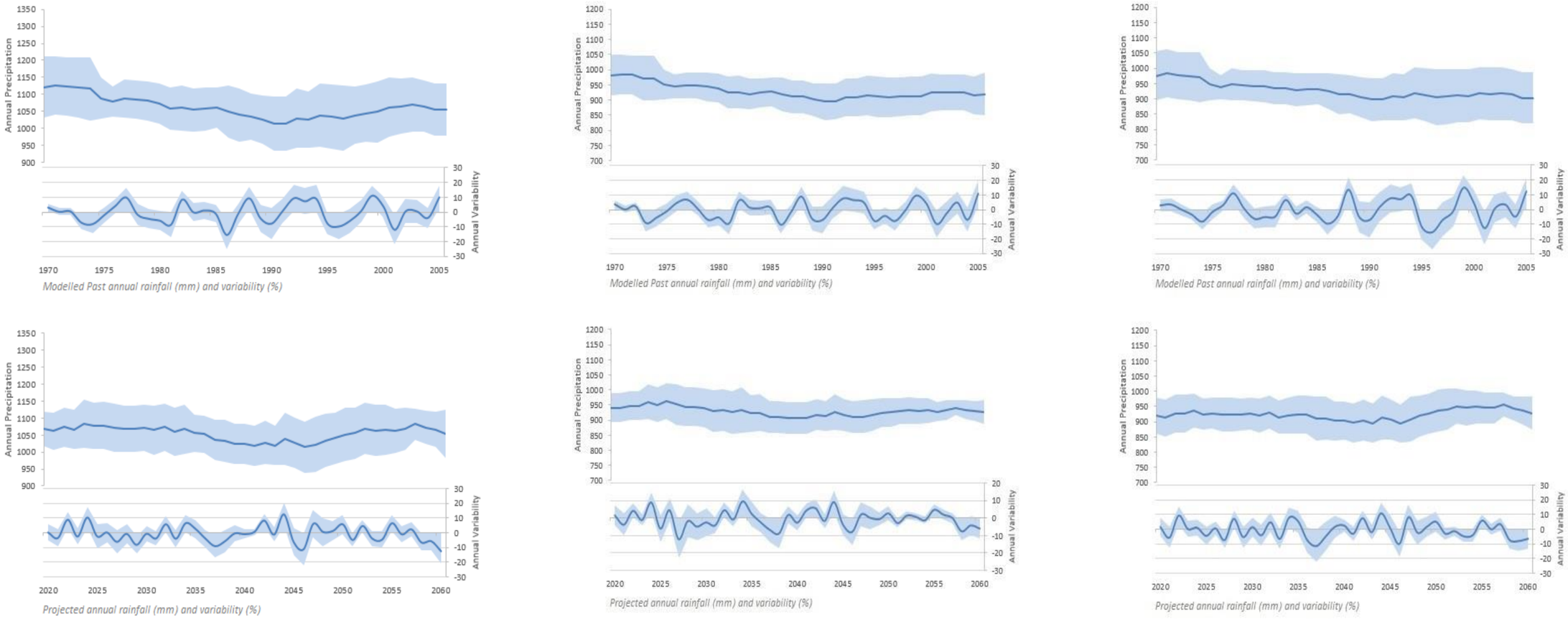


Figure 83: Annual average precipitation volumes and yearly variability potential for Coastal (left set), Inland South (centre set) and Inland North (right set) climate zones, Modelled past (top set), RCP4.5 Projected future (bottom set)

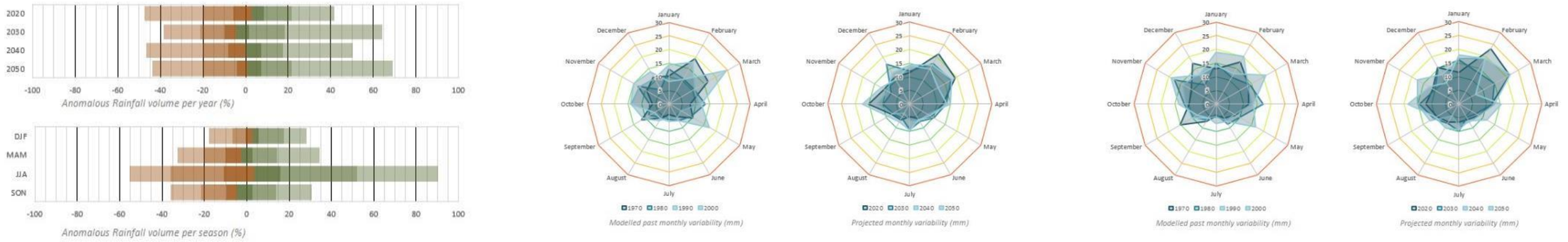


Figure 84: Monthly variability potential (mm volume) for Coastal (left set), Inland South (centre set) and Inland North (right set) climate zones, Modelled past (left of each set), RCP4.5 Projected future (right of each set)

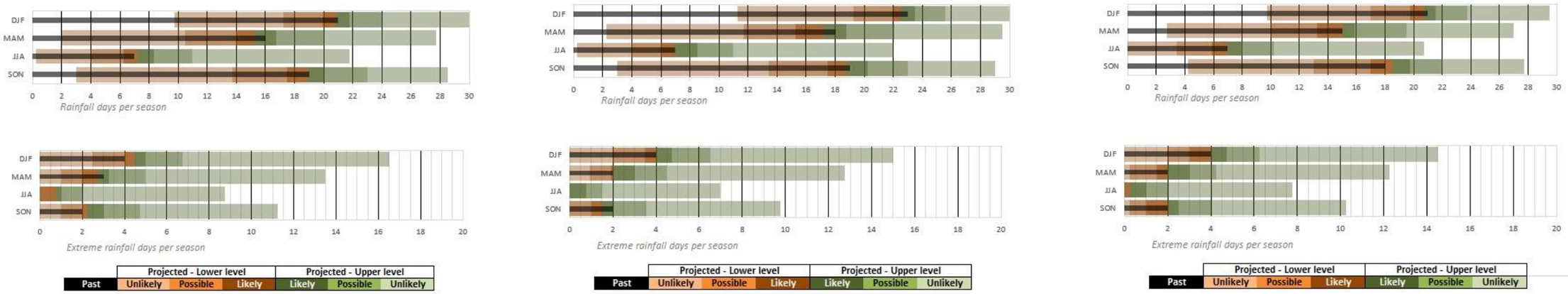


Figure 85: Number of rain days (top set) and extreme rainfall days (bottom set) per season for Coastal (left set), Inland South (centre set) and Inland North (right set) climate zones, Modelled past (thin black bars), RCP4.5 Projected future (thick brown and green bars)

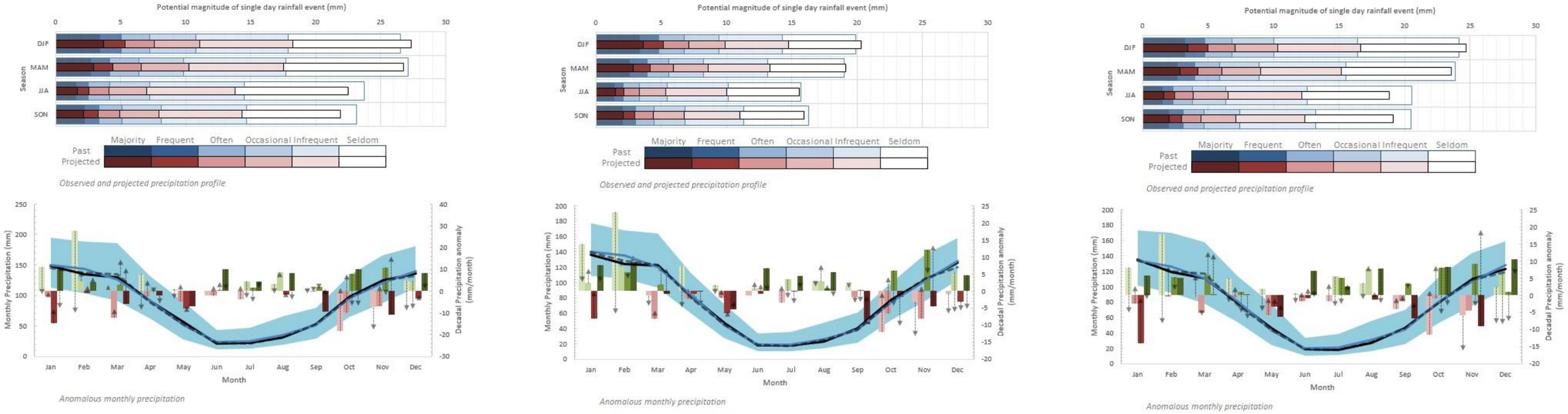


Figure 86: Rainfall Profile (top set), past and projected future monthly precipitation volumes (bottom set: blue lines and envelope) and RCP4.5 projected monthly anomaly from monthly mean per decade 2020, 2030, 2040, 2050 (bottom set: green and red bars, black arrows represent RCP8.5) for each climate zone, Coastal (left set), Inland South (centre set) and Inland North (right set)

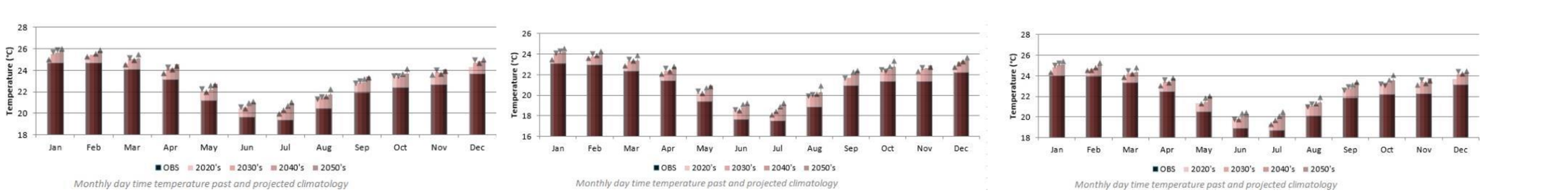


Figure 87: Anomalous projected temperature changes for 2020's, 2030's, 2040's, 2050's (lighter red bars), from the past temperatures (dark bars) for RCP4.5, arrows show further change under RCP8.5 for each climate zone, Coastal (left), Inland South (centre) and Inland North (right)

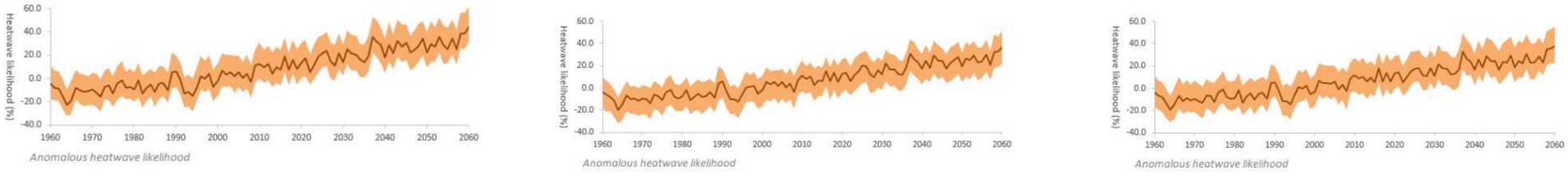


Figure 88: Anomalous change over time (from 1990-2000) of heatwave likelihood from RCP4.5 for each climate zone, Coastal (left), Inland South (centre) and Inland North (right)

Aurecon South Africa (Pty) Ltd
1977/003711/07
3rd Floor
Park Row Building
4-10 School Road
Pinetown
3610
PO Box 932
Pinetown
3600
South Africa
T +27 31 714 2500
F +27 31 702 0287
E eThekwini@aurecongroup.com
W aurecongroup.com

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ethiopia, Hong Kong, Indonesia, Lesotho, Libya, Malawi, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.