

Amajuba District Municipality



Climate Change Vulnerability Assessment and Response Plan

November 2017

Draft Version 1 – For Comment

Developed through the Local Government Climate Change Support Program



This climate change plan was developed through the Department of Environmental Affairs, Local Government Climate Change Support Program (LGCCSP). The LGCCSP is part of the [International Climate Initiative \(IKI\)](#) and is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

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1 Executive Summary

Amajuba District Municipality recognises climate change as a threat to the environment, its residents, and to future development. Therefore, measures should be implemented to reduce or eliminate carbon emissions or enhance greenhouse gas sinks (mitigation) (Böckmann, M 2015). However, due to lag times in the climate and biophysical systems, the positive impacts of past and current mitigation will only be noticeable in the next 25 years (Jiri, O 2016). In the meanwhile, adaptation is regarded as inevitable and a necessary response to the changes that are projected to take place in the District. Amajuba District Municipality has therefore prioritised the development of a Climate Change Vulnerability Assessment and Climate Change Response Plan.

The Climate Change Vulnerability Assessment and Response Plan was developed through the Local Government Climate Change Support (LGCCS) program (<http://www.letsrespondtoolkit.org/>), this program is led by the Department of Environmental Affairs. The LGCCSP is part of the International Climate Initiative (IKI) and is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Through this program key climate change vulnerability indicators for the Amajuba District Municipality were identified. These indicators demonstrate areas that maybe at high risk of climate change impacts.

A summary of the key vulnerability indicators is provided in the table below.

Table 1: Key Vulnerability indicators for Amajuba District Municipality

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
7	Agriculture	Change in other crop production areas (e.g. vegetables, nuts, etc.)	Yes	High	Low
10	Agriculture	Increased risks to livestock	Yes	High	Low
11	Agriculture	Reduced food security	Yes	High	Low

2 Introduction

This document outlines key climate change vulnerabilities and responses to address these vulnerabilities for XXXX District Municipality. The Climate Change Vulnerability Assessment and Response Plan were developed through the Local Government Climate Change Support Program (LGCCSP), an initiative of the National Department of Environmental Affairs and the International Climate Initiative (IKI) and is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

The three primary objectives of the LGCCSP are to:

- A desktop analysis of the municipality to provide context on change vulnerabilities and responses;
- Undertake district municipal specific engagements to draft climate change vulnerabilities and responses;
- Facilitate capacity building and knowledge-transfer throughout the program to enhance implementation of prioritised climate change adaptation options.

For more details on the LGCCSP please visit the website: <http://www.letsrespondtoolkit.org/>.

Through the LGCCSP, a Climate Change Vulnerability Assessment Toolkit was developed to assist municipalities to identify and prioritise climate change indicators to facilitate the assessment of adaptive capacity. Indicators are a range of potential impacts which have been developed using the Long Term Adaptation Scenario (LTAS) reports (Department of Environmental Affairs 2013). Indicators are grouped into the following themes:

- Agriculture
- Biodiversity and Environment
- Human Health
- Disaster Management, Infrastructure and Human Settlements
- Water

The LGCCS Toolkit was applied to the XXXX District Municipality to assist with the development of its Climate Change Response Plan.

2.1 Climate Change Introduction

2.1.1 Climate change defined

Climate change is a natural phenomenon that takes place over geological time. However, over the past few decades the rate of climate change has been more rapid and the magnitude of global warming has increased dramatically (Warburton, M.L and Schulze, R 2006; Warburton, M.L 2012). This change has been attributed to increased anthropogenic greenhouse gas emissions (Koske, J and Ochieng, M.A 2013). For example, the burning of coal to generate electricity, the burning of petrol in cars, some chemical processes in industries, and many farming activities all contribute to the increased concentration of greenhouse gasses in the atmosphere.

Climate change is not just an increase in average global temperatures but changes in regional climate characteristics such as rainfall, relative humidity and severe weather extremes (Davis, C.L 2011). Climate change can manifest as a shock or a stress (Ziervogel, G and Calder, R 2003). Shocks are defined as discrete, extreme events (rapid onset) such as floods, while gradual change (slow onset) such as long-term climate variability is classified as a stress (Ziervogel, G and Calder, R 2003).

The negative impacts of climate change “are already felt in many areas, including in relation to, *inter alia*, agriculture, and food security; biodiversity and ecosystems; water resources; human health; human settlements and migration patterns; and energy, transport and industry” (United Nations WomenWatch 2009, 1).

2.1.2 Climate Change Policy Context in South Africa

Climate change is a relatively new area of policy development in South Africa. As policies and structures are developed, it is necessary to ensure that they are evidence-based, coordinated and coherent. This section introduces international and national climate change policies and structures, which are listed below:

- The United Nations Framework Convention on Climate Change (UNFCCC). This international treaty provides guidance on setting agreements pertaining to the reduction of greenhouse gas emissions.
- The Paris Agreement, came into effect on 4 November 2016. This is the first agreement all countries have committed to and stipulates that all countries must reduce carbon emissions to limit global temperature increase to 1.5 degrees Celsius above pre-industrial levels.
- South Africa’s Nationally Determined Contributions, came into effect after the Paris Agreement was signed. South Africa is therefore required to report on mitigation and adaptation efforts. Concerning mitigation, South Africa is to reduce emissions by a range between 398 and 614 million metric tons of carbon equivalent by 2025 and 2030. There are several instruments to ensure reduction in carbon emissions including car tax and company carbon budgets among other instruments. With reference to adaptation a National Adaptation Plan is currently being developed, and climate change is to be incorporated in all policy frameworks, institutional capacity is to be enhanced, vulnerability and adaptation monitoring systems are to be in place, vulnerability assessment and adaptation needs framework are to be developed and there needs to be communication of past investments in adaptation for education and awareness.
- The National Climate Change Response White Paper (NCCRWP) was adopted in 2011 and presents the South African Government’s vision for an effective climate change response in the long-term, to transition to a climate-resilient and lower-carbon economy and society.
- The National Development Plan, focuses on eliminating poverty and reducing inequality by 2030 and creating an environmentally sustainable country through mitigation and adaptation efforts.
- Long Term Mitigation Scenarios, outline different scenarios of mitigation action for South Africa.
- Long Term Adaptation Scenarios, consist of two phases. Phase one, was the identification of climate change trends and projections as well as impacts and responses for the main sectors. Phase two focussed on integrating issues such as climate information and early warning systems, disaster risk reduction, human settlements and food security.

2.1.3 Climate Change Impacts in South Africa

South Africa's temperature is expected to increase to 1.2° C by 2020, 2.4° C by 2050 and 4.2° C by 2080 (Kruger, A.C and Shongwe, S 2004). Contrary to the global increase in rainfall, South Africa's rainfall is expected to decrease by 5.4% by 2020, 6.3% by 2050 and 9.5% by 2080 (Kruger, A.C and Shongwe, S 2004). The frequency and intensity of climate extremes, *inter alia*, droughts, floods, storms and wild fires will increase (Davis, C.L 2011; Böckmann, M 2015). Climate change evidence indicates changes in frequency and intensity of flood and prolonged drought events at small scales (Meyiwa, T et al. 2014). Furthermore, the sea level will continue rising and ocean acidification will get worse (Böckmann, M 2015).

There are however uncertainties associated with climate projections because they are based on the potential rates of resource use in the future, and associated greenhouse gas emissions (Nicholson-Cole, S.A 2005).

To aid in assessing the potential climate change impacts, the country has been divided into six hydrological zones (Figure 1 below). These hydrological zones not only reflect water management areas but have been grouped according to common climatic and hydrological characteristics (Department of Environmental Affairs 2013). Based on a range of data and projections, four possible climate scenarios have been identified for South Africa:

- Warmer/wetter (with greater frequency in extreme rainfall events),
- Warmer/drier (with an increase in frequency of drought and somewhat increased frequency of extreme rainfall events),
- Hotter/wetter (with substantially greater frequency of extreme rainfall events), and,
- Hotter/drier (with a substantial increase in the frequency of drought events and greater frequency of extreme rainfall events).

Projections on rainfall have also been developed for each of the hydrological zones (Department of Environmental Affairs 2013). The following four climate change scenarios have been described for the Pongolo Hydrological Zone (the dominant zone in KwaZulu-Natal) in the Department of Environmental Affairs' Long Term Adaptation Scenarios Reports. These are:

- Warmer wetter scenario - Increased rain in spring
- Hotter drier scenario - Decreased rain in spring & strongly decreased in summer & autumn
- Hotter wetter scenario - Strongly increased rain in spring
- Warmer drier scenario - Decreased rain in spring & strongly decreased in summer & autumn

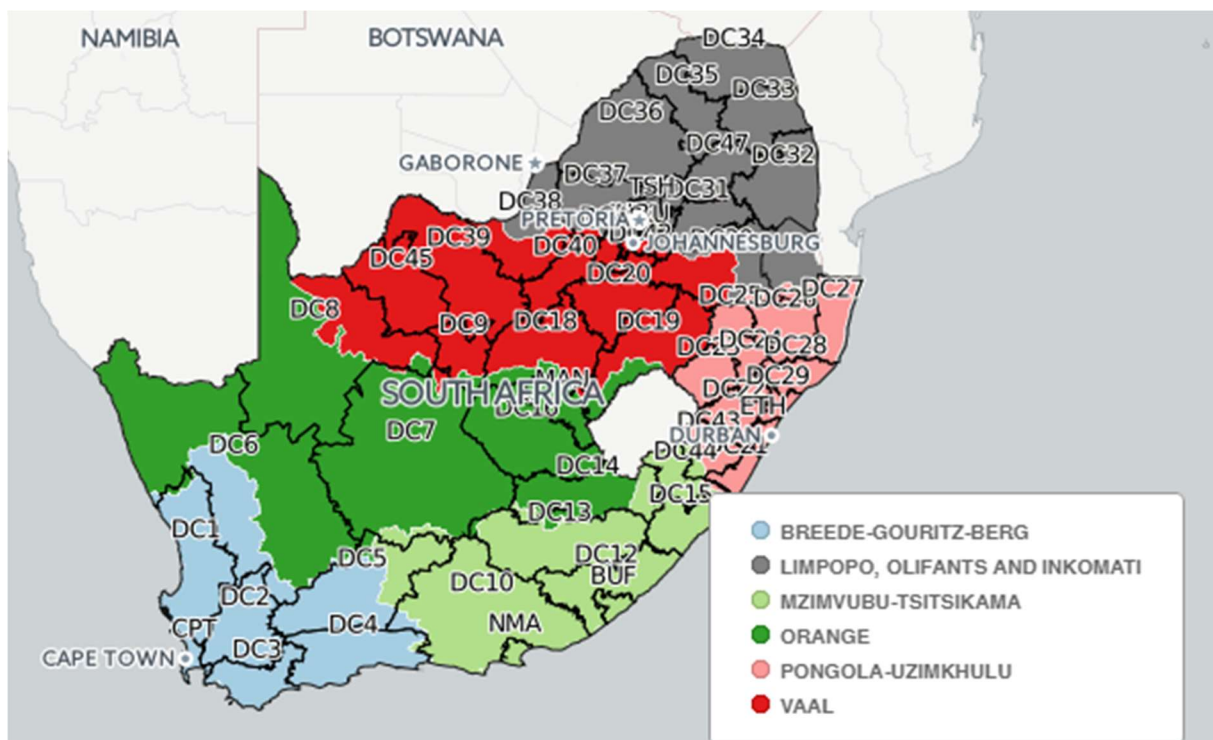


Figure 1: Hydrological Zones of South Africa

2.1.4 Provincial Climate Change Context

The KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (DEDTEA) has developed the Draft Climate Change Action Plan (June 2014). The plan covers both mitigation and adaptation strategies, but provides limited detail on adaptation strategies. For example, the plan only mentions the development of sector specific climate change response plans. A Status Quo Vulnerability Study of the Impacts of Climate Change in the KZN Province, developed by Department Agriculture, Environmental Affairs & Rural Development (DAEARD) in 2009, provides a much more detailed assessment of climate risks.

The KZN Council for Climate Change was established in 2012 to coordinate climate change management activities in the province. However, the council has not been operational over the past two years. KwaZulu-Natal has managed to secure some climate change funding, particularly through United Nations Industrial Development Organization (UNIDO) for mitigation activities. eThekweni Municipality has also secured funding through the Green Fund for the Buffelsdraai Community Reforestation Project.

Climate change poses a significant threat to KwaZulu-Natal's water resources, food security, health, infrastructure, ecosystem services and biodiversity (Montmasson-Clair, G and Zwane, M 2016). High vulnerability in the province is attributed to low adaptive capacity (Shezi, N and Ngcoya, M 2016) and biophysical sensitivity (Linkd Environmental services 2013).

The table below is a summary of the key climate change issues in the province as outlined in the Status Quo Vulnerability Study of the Impacts of Climate Change in KZN.

Table 2: Key climate change issues in KZN

Adaptation Category	Vulnerability Details
Natural systems	Natural systems highly susceptible to change Biggest risks are uncertainties to thresholds
Water resources	KZN already water stressed Potential increase in evaporation Increase in storm events and associated discharge events
Biodiversity resources	Climate change will increase already high rates of biodiversity degradation Potential for bio-climatic shifts to take place Species rich hotspots under threat
Fire regime	Bio-climatic shifts may change impacts of fire Need more research into fire regimes and climate change
Coastal zone	Observed changes in sea level Storm events already resulting in loss of property South Coast particularly vulnerable to coastal erosion
Agricultural sector	Net loss of cold to moderate climatic zones and a potential increase in warm sub-tropical and tropical areas Potential increase in new pests

3 Methodology

This climate change response plan was developed through a combination of desktop research and stakeholder engagement activities. Initially, desktop research was conducted on the climate change status quo for each of the key sectors in the district. This research was used for the basis of the stakeholder engagement activities.

The workshop methodologies were based on the active-based learning theory approach. Action learning is an approach used to train and to encourage stakeholders to solve real life problems. The workshop methodologies ensured there was a focus on knowledge exchange and capacity building at the workshops.

There were four stakeholder engagement occurrences. These were:

1. Provincial level workshop, where key stakeholders were introduced to the core concepts of climate change and the LGCCSP program. The exposure component of the vulnerability assessment was also undertaken by various stakeholders at this workshop, including government officials and other key community members. The workshop therefore involved presentations, participatory exercises and associated discussions.
2. A District Municipality Level workshop, where the focus was specifically on the identification and review of key climate change vulnerabilities for the area. A more detailed vulnerability assessment was undertaken by the participants. The process included the identification of context specific climate change indicators, assessing exposure, sensitivity and adaptive capacity.
3. A second District Municipality Level workshop, where key stakeholders were invited to review the vulnerability assessment process and develop priority climate change responses.
4. A final Provincial Level workshop, where key stakeholders were invited to present their municipal climate change plans.

These workshops aimed to provide the necessary tools, build capacity and provide support to stakeholders to develop and review existing Climate Change Vulnerability Assessments and response plans.

3.1 What is a Vulnerability Assessment?

According to the [IPCC](#) (Parry et al. 2007) "vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change". A vulnerability assessment therefore is a multifaceted assessment of an areas vulnerability to climate change. Nelitz et al. further define a climate change vulnerability assessment as "a process for assessing, measuring, and/or characterizing the exposure, sensitivity, and adaptive capacity of a natural or human system to disturbance"(Nelitz, M, Boardley, S, and Smith, R 2013). The methodology used in assessing climate change vulnerability for the District used the three assessment criteria, namely: exposure, sensitivity and adaptive capacity.

- **Exposure** refers to the magnitude and extent, to which a municipal area is exposed to climate change impacts (Amos, E, Akpan, U, and Ogunjobi, K 2015) and is a function of one's location and environment.
- **Sensitivity** on the other hand refers to the extent to which a municipal area is affected by the climate change impacts
- The [IPCC](#) (Parry et al. 2007) formally defines **adaptive capacity** as: "The ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences".

Exposure and sensitivity, increases one’s vulnerability to climate change while adaptive capacity decreases vulnerability. The above-mentioned components allow for more detailed characterizations of climate change vulnerability.

3.2 Steps involved in a Vulnerability Assessment

Four steps were followed when conducting a vulnerability assessment, they are:

- Step 1: Identify indicators potential impacts.
- Step 2: Assess whether the impact will take place (exposure).
- Step 3: Assess how important the risk is (sensitivity).
- Step 4: Assess if you can respond to the risk (adaptive capacity).

Figure 2 below illustrates how the components of a Climate Change Vulnerability Assessment link to each other.

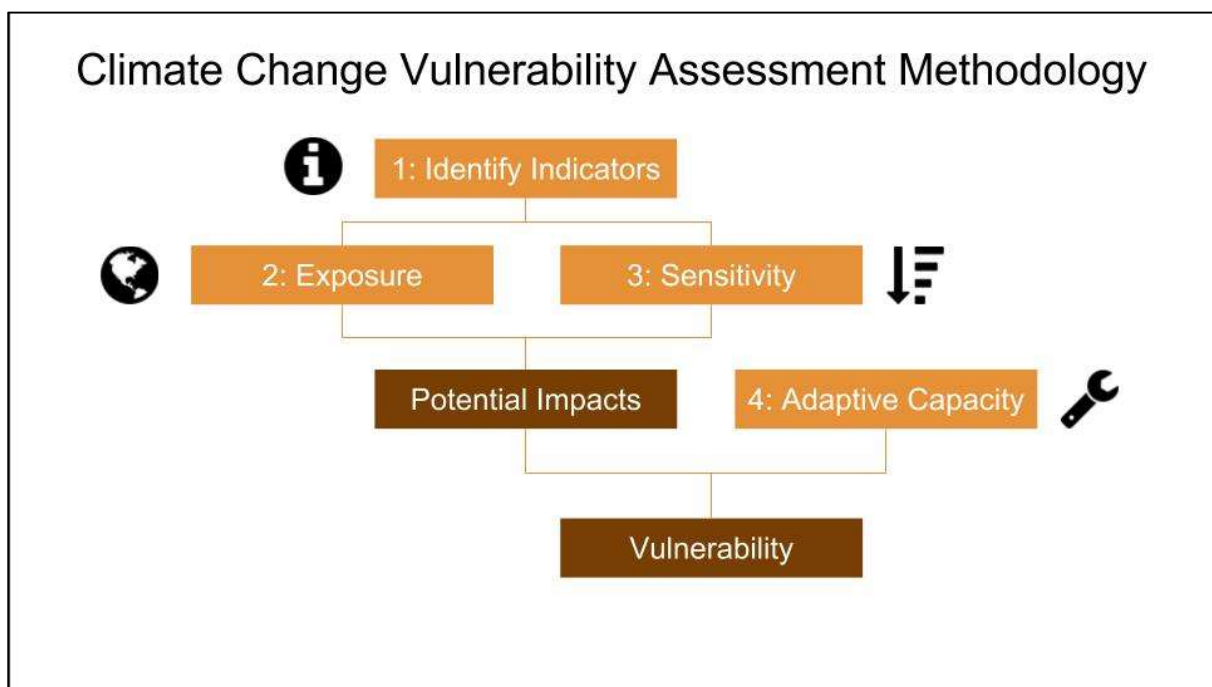


Figure 2: Vulnerability Assessment Methodology

3.3 Step 1: Develop Climate Change Indicators

As mentioned above, the first step in a Climate Change Vulnerability Assessment is the identification of context specific indicators. Essentially, indicators are potential climate change induced impacts in a specific area. The LGCCSP Vulnerability Assessment Toolkit developed a draft of several indicators using the [Long Term Adaptation Scenario Reports](#) (Department of Environmental Affairs 2013). The indicators are grouped into six sectors (agriculture; biodiversity and environment; coastal and marine; human health; disaster management, infrastructure and human settlements; and water).

3.4 Step 2: Assessing Exposure

The assessment of exposure followed the identification of indicators. Exposure assessment aimed to ascertain whether the identified indicators are relevant in the District Municipality. If the District Municipality was exposed to a particular indicator, stakeholders scored that indicator a 'yes'.

3.5 Step 3: Assessing Sensitivity

The third step of the Climate Change Vulnerability Assessment 'asks' the question, "if you are exposed, how important is the potential impact?" This is termed "sensitivity" and is assessed using a graded scale (High, Medium, Low). If an indicator scored a "yes" in the exposure assessment, the sensitivity of the Municipality to that indicator was then analysed using the graded scale.

3.6 Step 4: Assessing Adaptive Capacity

Once exposure and sensitivity were determined, the next step was the assessment of adaptive capacity. The question directed at stakeholders during the workshop was "If there are going to be significant impacts due to climate change, do you have the necessary systems (policy, resources, social capital) in place to respond to the change?"

The indicators that scored "yes" for the exposure questions and "high" or "medium" for the sensitivity questions, were then assessed in terms of adaptive capacity. For the purpose of the LGCCS Vulnerability Assessment Toolkit, the guiding question was "Do you have high, medium or low adaptive capacity (policy, institutional, social and finance) to respond to the change?" The adaptive capacity answers were scored using a graded scale (high, medium or low).

Those that scored a "low" or "medium" were recorded as indicators with potential adaptive capacity constraints in XXXX District Municipality.

3.7 Step 5: Develop Response Plans for Priority Indicators

Upon completion of the exposure, sensitivity and adaptive capacity assessments, priority indicators were identified using the criteria below:

- Exposure - Yes
- Sensitivity - High or Medium
- Adaptive Capacity - Low or Medium

Priority indicators are perceived to be the ones the district is most vulnerable to. A response plan was then developed to address climate change vulnerabilities and inform resource allocation for climate change adaptation. To facilitate the development of a response plan, stakeholders were given a LGCCS generic response plan template for each sector, which was used as a starting point to develop sector specific response plans for Amajuba District Municipality.

3.8 Desired Adaptation Outcomes

The Department of Environmental Affairs (DEA) has developed (ongoing process) a set of Desired Adaptation Outcomes (DOAs). The DOAs provide evidence of climate change impacts and of responses to climate change in South Africa. DOAs identify desired states that, individually and in combination, will contribute to climate resilience in the short to medium-term (i.e. over the next five to 20 years). They aim to provide clear insights into climate change adaptation in South Africa and help capture the country's unique circumstances to aid reporting on adaptation at national and international levels. They also provide a means of assessing the capacity of 'at risk' sectors and their stakeholders to adapt to climate change and whether the measures being taken are appropriate, efficient and effective.

The current set of DOAs are provided below:

- G1 - Robust/integrated plans, policies and actions for effective delivery of climate change adaptation, together with monitoring, evaluation and review over the short, medium and longer-term.

- G2 - Appropriate resources (including current and past financial investments), capacity and processes (human, legal and regulatory) and support mechanisms (institutional and governance structures) to facilitate climate change adaptation.
- G3 - Accurate climate information (e.g. historical trend data, seasonal predictions, future projections, and early warning of extreme weather and other climate-related events) provided by existing and new monitoring and forecasting facilities/networks (including their maintenance and enhancement) to inform adaptation planning and disaster risk reduction.
- G4 - Capacity development, education and awareness programmes (formal and informal) for climate change adaptation (e.g. informed by adaptation research and with tools to utilise data/outputs).
- G5 - New and adapted technologies/knowledge and other cost-effective measures (e.g. nature-based solutions) used in climate change adaptation.
- G6 - Climate change risks, impacts and vulnerabilities identified and addressed.
- G7 - Systems, infrastructure, communities and sectors less vulnerable to climate change impacts (e.g. through effectiveness of adaptation interventions/response measures).
- G8 - Non-climate pressures and threats to human and natural systems reduced (particularly where these compound climate change impacts).
- G9 - Secure food, water and energy supplies for all citizens (within the context of sustainable development).

The activities in the Sector Response Plans below are have a column to allocate to the DOAs. This will assist the DEA to monitor and evaluate the implementation of climate change adaptation throughout the country.

4 District Snapshot Amajuba District Municipality

Amajuba District Municipality is one of ten district municipalities within the KwaZulu-Natal Province. The district is in the north-western corner of the province and comprises of the following three local municipalities: Dannhauser, eMadlangeni, and Newcastle local municipality. The district municipal area has a total population of 499 839 less than 10% of the province's total population (Statistics South Africa 2011). The district is a mix of rural (mainly eMadlangeni and Newcastle local municipalities) and urban (most of Dannhauser local municipality) areas (Amajuba District Municipality 2017). The Newcastle local municipality is home to most of the district's population. Climate change is one of the two critical environmental challenges in the district, the other being environmental degradation.

4.1 Key District Indicators

The table below provides a summary of the key indicators for the District. The table lists the national indicators for comparison purposes. Many of these indicators are used in the climate change vulnerability assessment process below.

Table 3: Key District Municipal Indicators for Amajuba DM compared to the National Average

General Information	Amajuba District Municipality	South Africa
Code	DC25	
Province	KwaZulu-Natal	
Seat	Newcastle	
Area (km ²)	6911	1219740
Census Statistics		
Criteria	Amajuba District Municipality	South Africa
Population	499839	51770553
Age Structure		
Population under 15	33.69%	29.17%
Population 15 to 39	42.95%	44.30%
Population 40 to 64	18.71%	21.19%
Population over 65	4.66%	5.34%
Dependency Ratio		
People in age group 0-14 & 65+, supported by age group 15-64	62.2%	52.7%
Employment (between 15 and 64)		
Employed	25.84%	38.87%
Not economically active	49.50%	39.21%
Unemployed	16.56%	16.50%
Discouraged work-seeker	8.10%	5.41%
Education (aged 20 +)		

Post School Qualification	7.53%	9.94%
Grade 12/Matric	30.47%	27.83%
High School	31.15%	32.16%
Less than High School	18.54%	16.43%
Other	12.31%	13.64%
Vulnerability Indicators		
Criteria	Amajuba District Municipality	South Africa
Household Dynamics		
Households	110967	14450151
Average household size	4.50	3.58
Percentage households involved in agricultural activities	35.97%	20.56%
Dwelling Type		
Percentage Households that are Informal Dwelling	4.59%	13.58%
Percentage Households that are Traditional Dwelling	7.16%	7.89%
Combined Percentage Households that are Traditional and Informal Dwelling	11.75%	21.47%
Sources of Water		
Percentage of Population that sources water from Boreholes	0.65%	1.76%
Percentage of Population that do not source water from piped water schemes	18.72%	21.82%
Percentage of Population that source water from Service Providers (e.g. Municipalities)	81.28%	78.18%
Percentage of Population that sources water from Water Tanks	4.73%	2.67%
Electricity Usage		
Percentage of households that use alternatives to electricity for cooking	25.24%	26.12%
Percentage of households that use alternatives to electricity for cooking, heating or lighting	15.37%	17.77%
Sanitation		
Percentage Population with flush toilets	44.41%	56.51%
Percentage Population using pit latrines	42.43%	30.73%
Percentage of Population with no toilet facilities	2.85%	5.34%
Percentage of Population with other toilet facilities	10.30%	7.42%
Refuse		
Percentage of Households with no rubbish disposal	4.77%	5.97%

Percentage of households with refuse removed by local authority/private company	53.13%	59.40%
Health		
Percentage of young (<5yrs) and elderly (>64yrs)	16.38%	16.32%
Percentage workforce employed in the informal Sector	15.53%	12.20%
Vulnerability Tool Indicators		
Criteria	Amajuba District Municipality	South Africa
Percentage households involved in agricultural activities	35.97%	20.56%
Percentage Population with flush toilets	44.41%	56.51%
Percentage of young (<5yrs) and elderly (>64yrs)	16.38%	16.32%
Percentage Households that are Traditional and Informal Dwelling	11.75%	21.47%
Percentage of Households with no rubbish disposal	4.77%	5.97%

4.2 Amajuba DM Agriculture Sector Summary

Within the Amajuba District Municipal Area, commercial agriculture mainly consists of privately owned farms (Amajuba District Municipality 2013). The main agricultural activities in the Amajuba District Municipal Area are the production of crops (mainly maize, soybean and wheat), beef and poultry (Amajuba District Municipality 2013). Commercial forestry also occurs in the Amajuba District Municipal Area (Amajuba District Municipality 2013). Most of the commercial agriculture areas are found in the Emadlangeni Local Municipality, with a notable amount occurring in the Newcastle Local Municipality (Amajuba District Municipality 2013). Some commercial livestock farming occurs in Dannhouser Local Municipality but the main agricultural activity in the Dannhouser Local Municipality is subsistence farming (characterised by mixed crop and livestock farming) in its more rural parts (Amajuba District Municipality 2013).

The commercial agriculture sector in the Amajuba District Municipal Area is considered to be important for employment in the Local Municipalities, yet it remains one of the lowest employers in the District Municipality as a whole (Amajuba District Municipality 2013). Specifically, as one of the smallest employers, the agriculture sector employs a mere 4.5% of the District Municipality's population (Amajuba District Municipality 2017). However, the 2011 South African Census estimated that 35.9 % of households are involved in agriculture activities within the Amajuba District Municipal Area (Figure 3) (Statistics South Africa 2011). In the map (Figure 3) the darker areas indicate higher percentages of households involved in the agriculture sector (Statistics South Africa 2011).

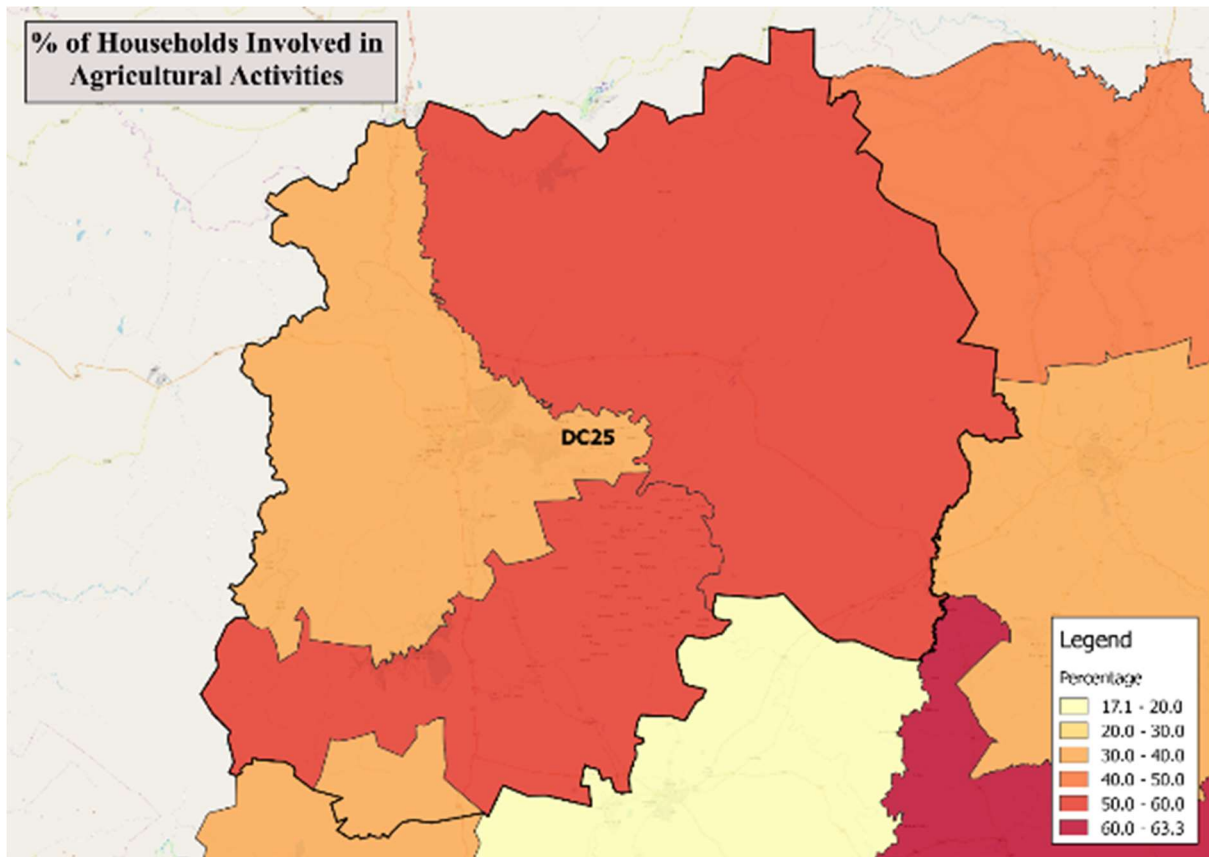


Figure 3: Percentage of households involved in agricultural activities across the District Municipal Area (Statistics South Africa 2011)

The Amajuba District Municipality's 2013 *Spatial Development Framework* notes that agriculture has the potential to increase economic growth and development in the Amajuba District Municipal Area through the creation of additional employment and business opportunities (Amajuba District Municipality 2013). This is why the agricultural sector is considered to be one of the key economic sectors in the Amajuba District Municipality (Amajuba District Municipality 2013). Focus on the development of the agriculture sector has increased in recent years due to the contracting of other sectors in the Amajuba District Municipality (Amajuba District Municipality 2017).

In spite of this additional focus, the economic contribution of the Amajuba District Municipality's agriculture sector has mostly decreased since 2003 (KwaZulu-Natal Provincial Treasury 2014). Specifically, the economic contribution of the agriculture sector declined from 5.0% in 2003 to 4.1% in 2013 (KwaZulu-Natal Provincial Treasury 2014). This decline has led to a loss of jobs in the Amajuba District Municipality's agriculture sector (Amajuba District Municipality 2017). The decline in the agriculture sector in Amajuba District Municipality has been attributed to: land claims as well as issues relating to funding, infrastructure, support for farmers and access to markets (Amajuba District Municipality 2017).

Despite the decline in the agriculture sector in the Amajuba District Municipal Area, the Amajuba District Municipality is well-known for beef production (Amajuba District Municipality 2006). Cattle farming is the main livestock farming activity in the Amajuba District Municipal Area and the cattle are predominantly of the indigenous Nguni breed (Amajuba District Municipality 2013). For livestock, the *Amajuba Agriculture Plan* notes that much of the grazing land in the District Municipal Area is of a poor to moderate condition (Amajuba District Municipality 2006). Improvements in land

management in the Amajuba District Municipal Area could result in considerable improvements to agricultural output (Amajuba District Municipality 2006).

In addition to livestock farming, the Amajuba District Municipal Area has an estimated 8,500 hectares under maize production (Amajuba District Municipality 2006). Maize is the most important crop in the District Municipal Area followed by soybeans (Amajuba District Municipality 2006). Maize yields in the region have consistently increased since the 1970s and these days commercial farmers produce 10 to 12 tons per hectare (t/ha) on irrigated land and about 6 t/ha on dry land (Amajuba District Municipality 2006). The potential for maize yields in the Amajuba District Municipal Area are shown in Figure 4 (Schulze and Walker 2007a). The map (in Figure 4) is divided into 'mesozones'. Mesozones are areas (spatial zones) of approximately the same size that are split by geographic as well as social boundaries such as rivers and areas of varying human activity (stepSA 2016). Each mesozone is roughly 50 square kilometres in size and allows for more accurate representations of activities or features (stepSA 2016).

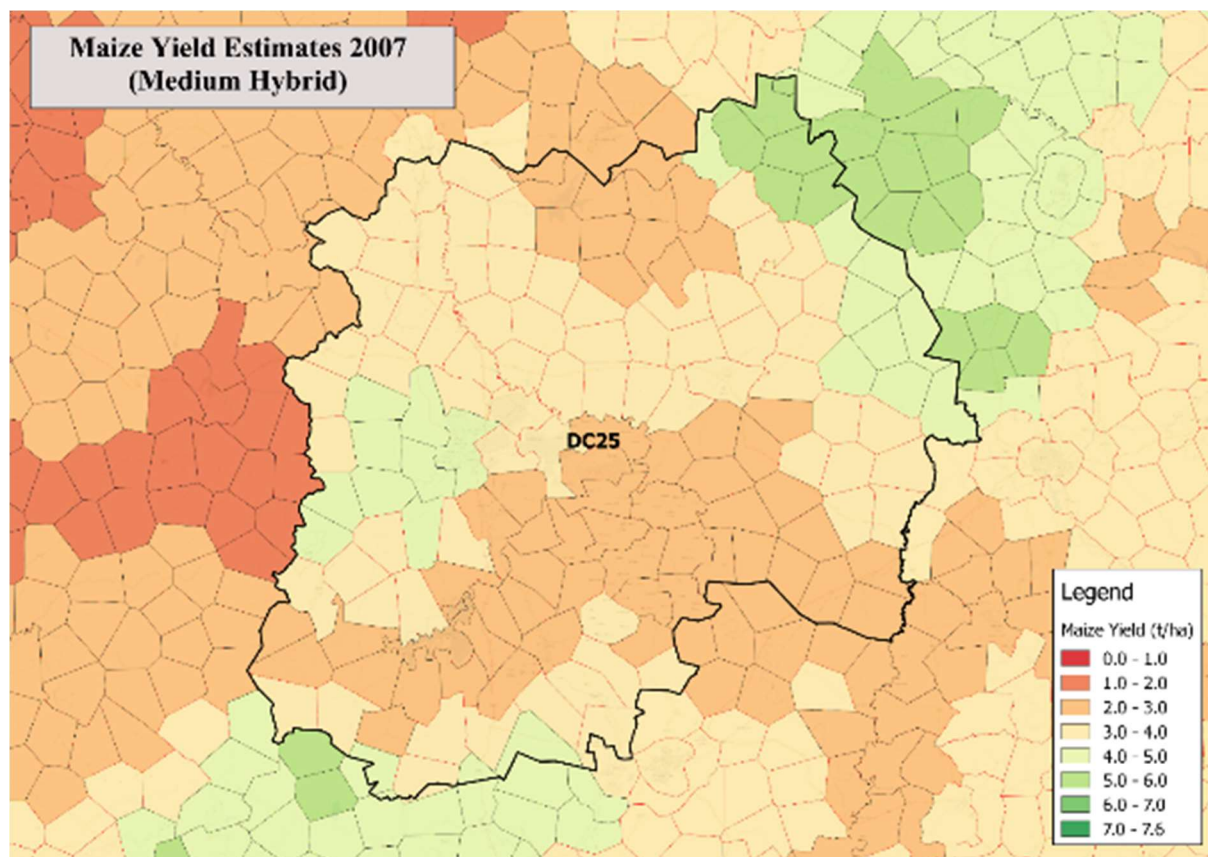


Figure 4: Maize (medium hybrid) yield estimates per mesozone across the District Municipal Area (Schulze and Walker 2007a)

In addition to maize, there is potential for sorghum and soybean production in the Amajuba District Municipal Area. Sorghum is spread across the District Municipal Area and yields could potentially be as high as 8 t/ha are possible (Figure 5) (Schulze and Walker 2007b). Although Soybean production (Figure 6) has less potential (yields range from 0 – 3 t/ha), it is also spread across the District Municipal Area (Schulze and Walker 2007c).

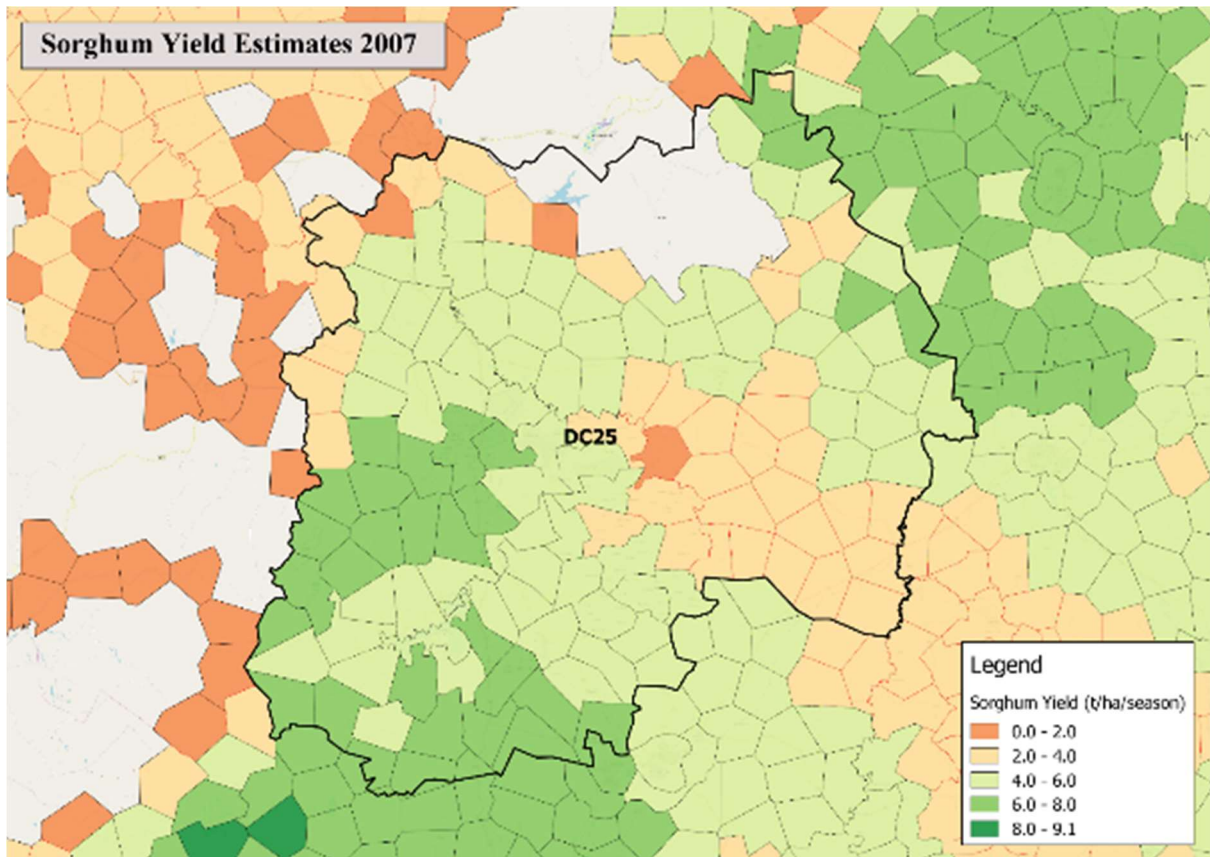


Figure 5: Sorghum yield estimates per mesozone across the District Municipal Area (Schulze and Walker 2007b)

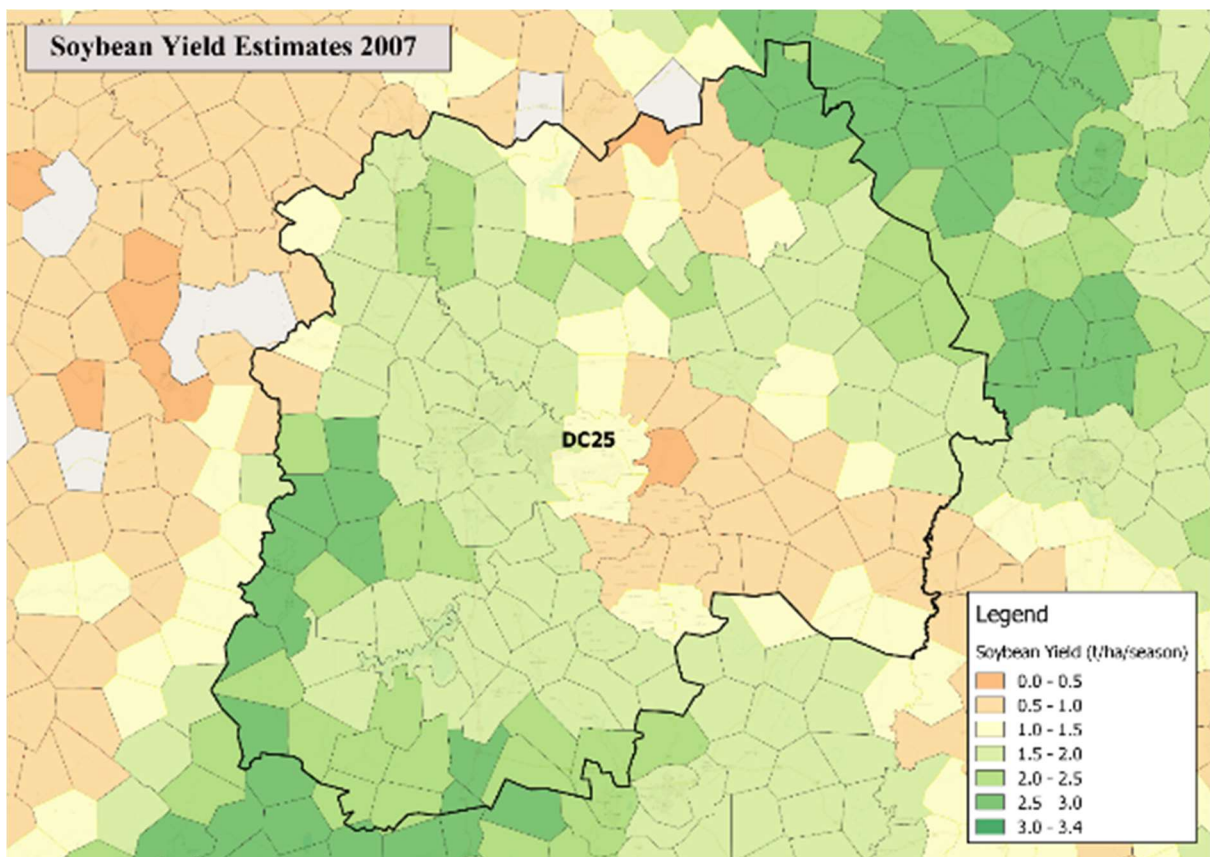


Figure 6: Soybean yield estimates per mesozone across the District Municipal Area (Schulze and Walker 2007c)

There is also potential for dryland (non-irrigated) sugar cane production throughout the entire District Municipal Area (Figure 7), with potential yields in some areas as high as 80 t/ha (Schulze and Walker 2007d).

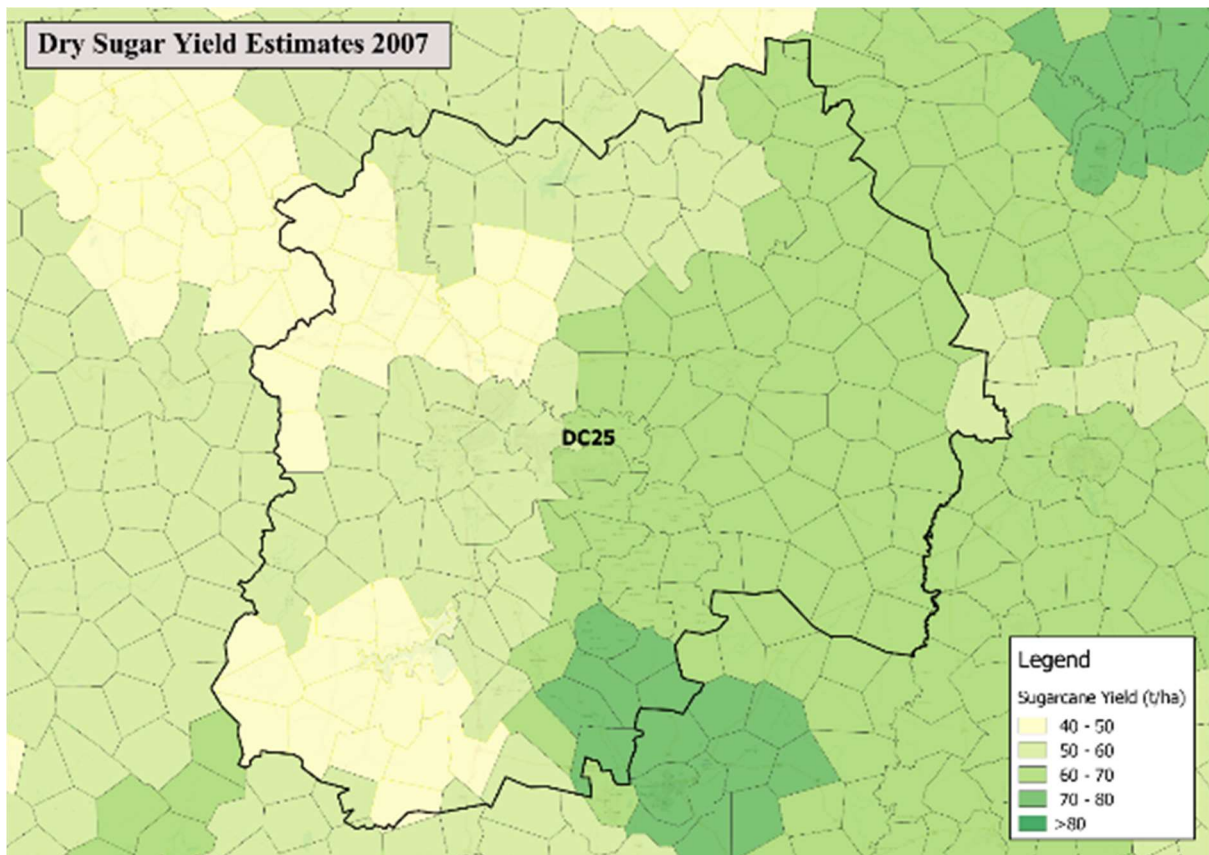


Figure 7: Dryland sugar yield estimates per mesozone across the District Municipal Area (Schulze and Walker 2007d)

Additionally, commercial forestry currently takes place within the Amajuba District Municipal Area (Figure 8). Commercial forests (consisting of *Pinus* and *Eucalyptus* species) occur in some parts of the Amajuba District Municipal Area (De Lange 2013).

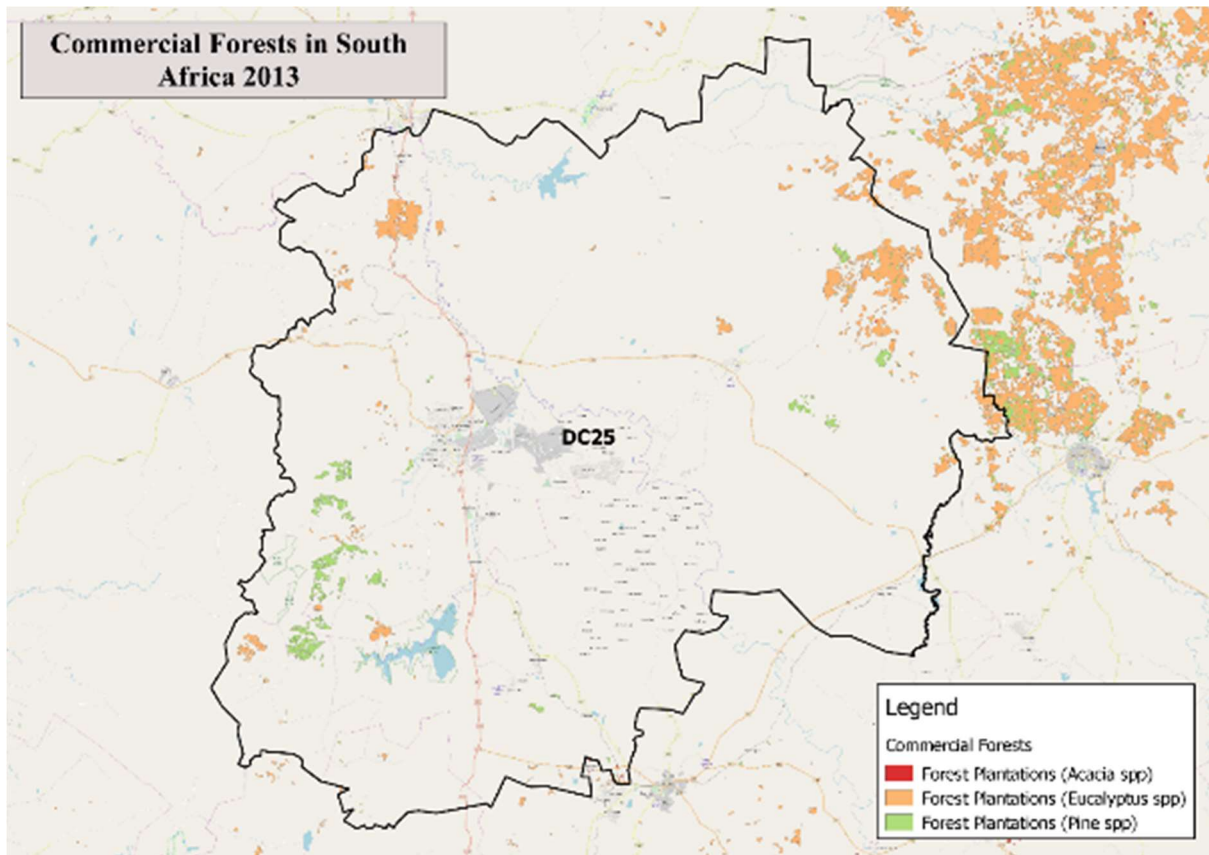


Figure 8: Commercial Forestry distribution across the District Municipal Area (De Lange 2013)

Despite the potential for expanding agricultural production in the Amajuba District Municipal Area, it is predicted that climate change will affect the agriculture sector both positively and negatively. The Long Term Adaptation Scenarios Flagship Research Programme (LTAS) forecasts that in the future, parts of eastern South Africa will become more suitable for grain production (Department of Environmental Affairs 2013c). The LTAS has also forecast that the production of sugarcane and fruit (such as apples and pears) will be increasingly vulnerable to damage from a predicted expansion of the areas affected by agricultural pests (Department of Environmental Affairs 2013c).

Furthermore, climate change is predicted to increase the total average rainfall in the Amajuba District Municipal Area (Department of Environmental Affairs 2013c). This could increase the agricultural output of maize, soybean and sugar cane as well as commercial forestry plantations (Department of Environmental Affairs 2013c). However, climate change is also predicted to increase rainfall variability and decrease water security in South Africa, which will negatively affect agricultural production in the District Municipal Area (Amajuba District Municipality 2016a).

4.3 Amajuba DM Biodiversity Sector Summary Structure

The Amajuba District Municipal Area is covered by the Grassland Biome (Figure 9). The Grassland Biome is characterised by a single layer of grass with varying degrees of land-cover depending on rainfall and grazing practices. The Grassland Biome is essential for agriculture in South Africa and has the second highest level of biodiversity after the Fynbos Biome (Mucina and Rutherford 2006).

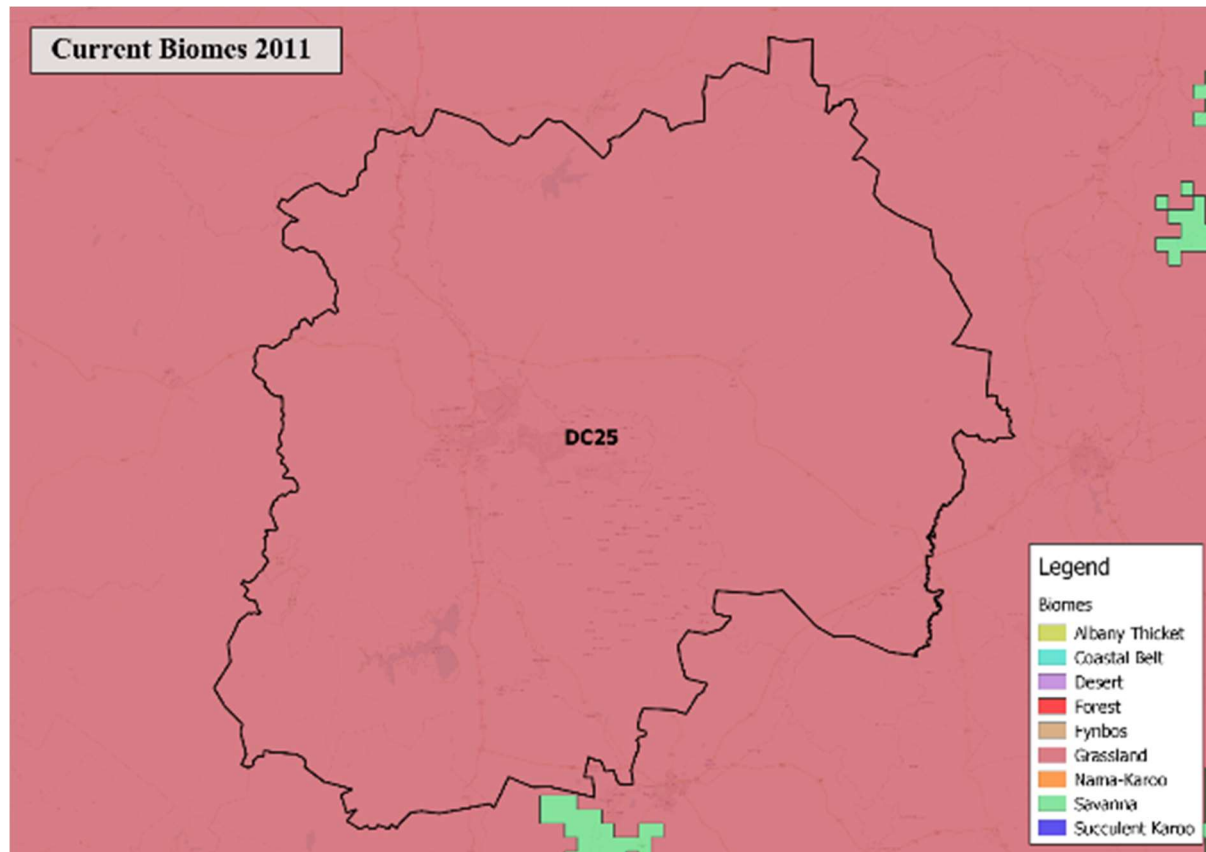


Figure 9: Current biome delineation in the District Municipal Area (South African National Parks 2011a)

Climate change is predicted to shift the biomes in South Africa, resulting in a change to the ecosystems and vegetation found in the Amajuba District Municipal Area. The Long Term Adaptation Scenarios Report on biodiversity highlights the following biomes as the most vulnerable and “in need of strong protection, restoration and/or research” (Department of Environmental Affairs 2013b).

- Highest priority for action: Grassland and Indian Ocean Coastal Belt.
- High priority for action: Fynbos and Forest.
- Medium priority for action: Nama Karoo and Succulent Karoo.

The maps below (Figure 10 and Figure 11) show the shift in biomes in the Amajuba District Municipal Area given different climate scenarios modelled by the South African National Biodiversity Institute (SANBI) in 2011. It is forecast that under a medium risk climate scenario, more than half of the land currently covered by the Grassland Biome will be replaced by the Savanna Biome. Under a high risk climate scenario, it is forecast that a nearly complete loss of the Grassland Biome will occur with it being replaced by the Savanna Biome.

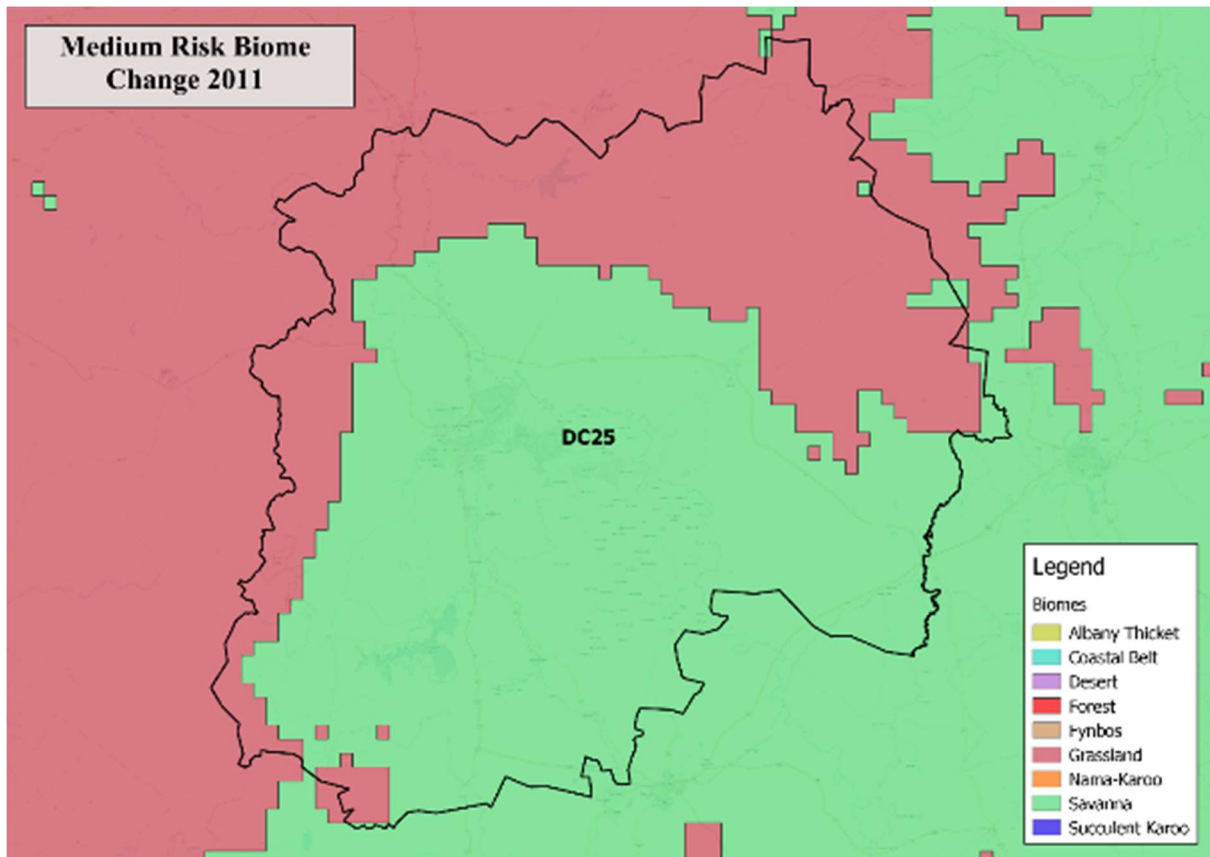


Figure 10: Predicted shift in biomes in the District Municipal Area using a medium risk scenario (South African National Parks 2011c)

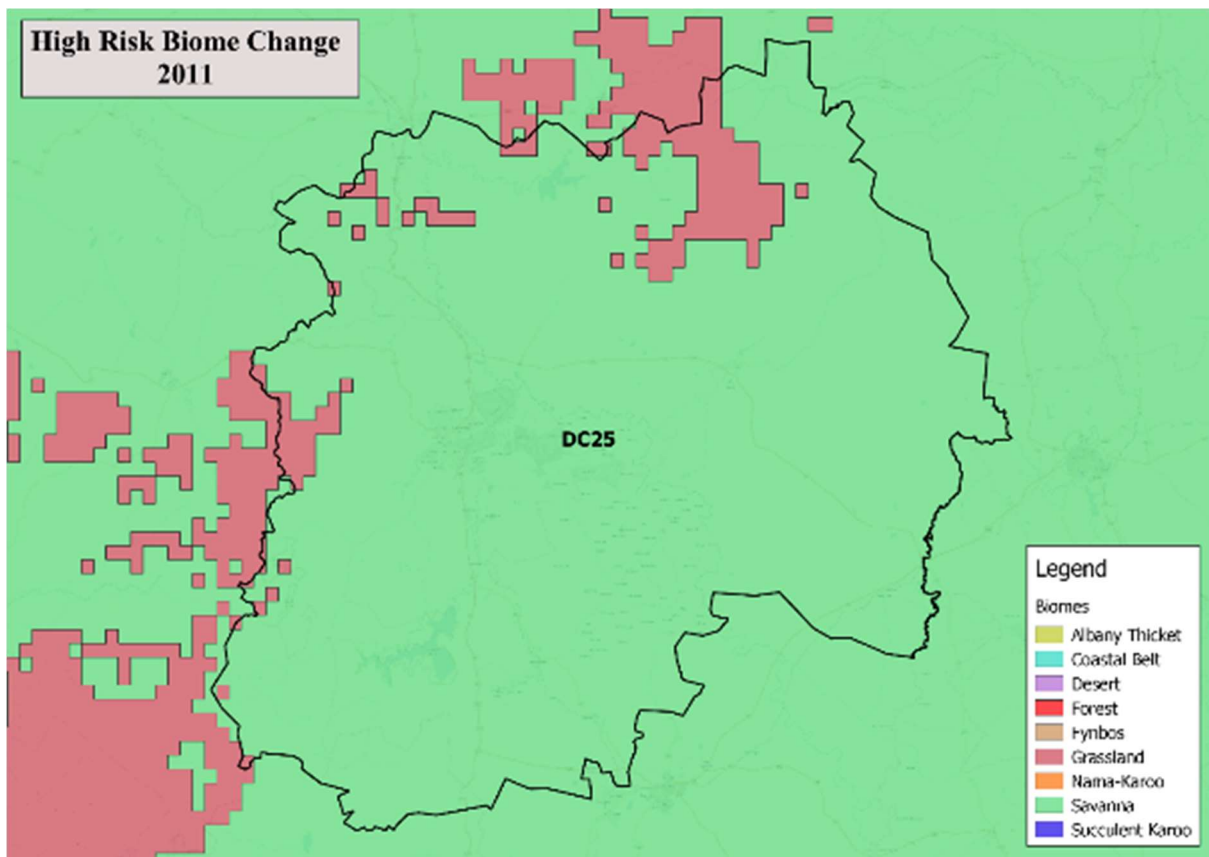


Figure 11: Predicted shift in biomes in the District Municipal Area using a high risk scenario (South African National Parks 2011b)

Within the Biomes found in the Amajuba District Municipal Area, there are several threatened ecosystem types (Figure 12). Endangered ecosystem types in the Amajuba District Municipal Area include: 'Bivane Montane Grasslands', 'Fort Metcliff Grasslands' and southern edged of the 'Wakkerstroom/Luneberg Grasslands' (South African National Biodiversity Institute 2011). Several vulnerable ecosystem types also occur in the Amajuba District Municipal Area (South African National Biodiversity Institute 2011).

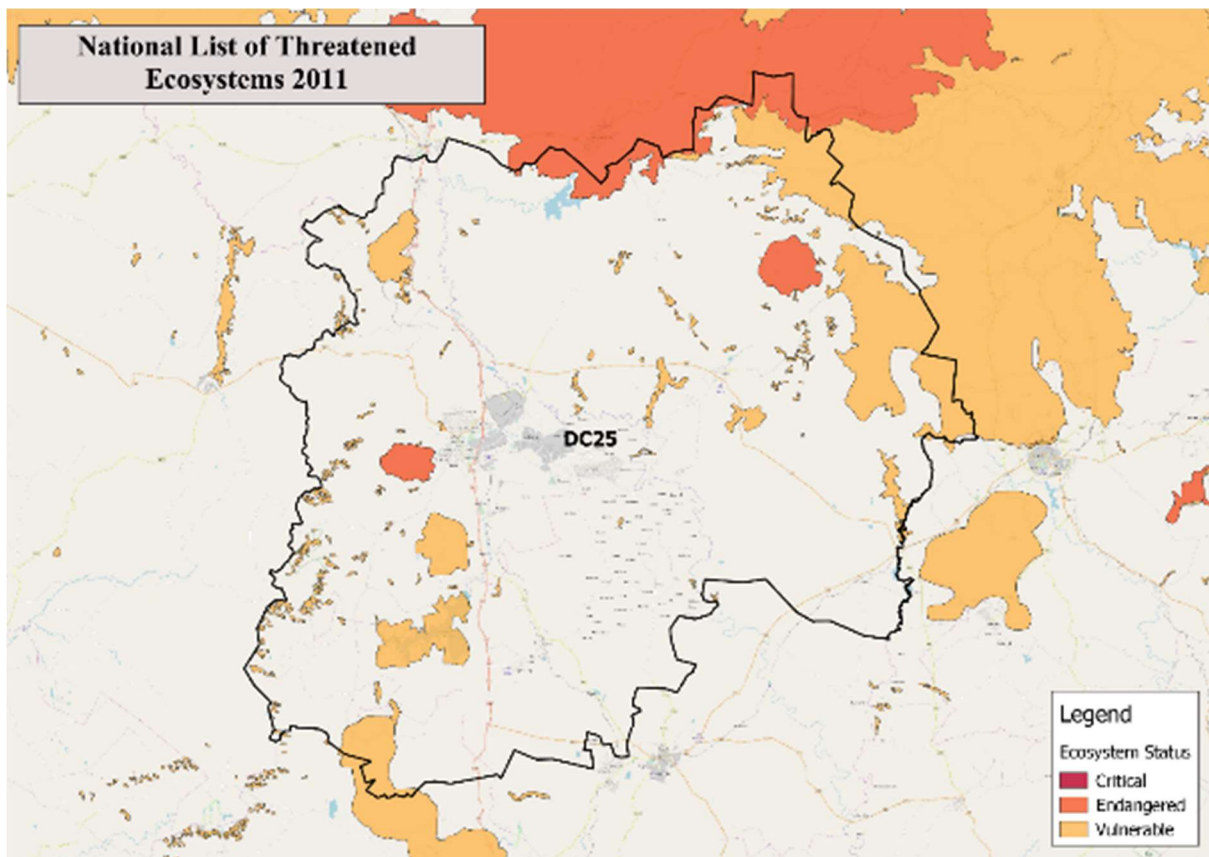


Figure 12: Threatened ecosystem types in the District Municipal Area (South African National Biodiversity Institute 2011)

In South Africa, a 'protected area' is defined as areas of land (e.g. a national park) or ocean (e.g. a marine protected area) that is legally protected and managed for the conservation of biodiversity, as per the National Environmental Management: Protected Areas Act (No. 57 of 2003) (Department of Environmental Affairs 2009). Internationally, the International Union for Conservation of Nature's (IUCN) definition of protected area includes areas that are not legally protected, which the Department of Environmental Affairs refers to as 'conservation areas' (Department of Environmental Affairs 2009). Within the Amajuba District Municipal Area there are four protected areas (Figure 13).

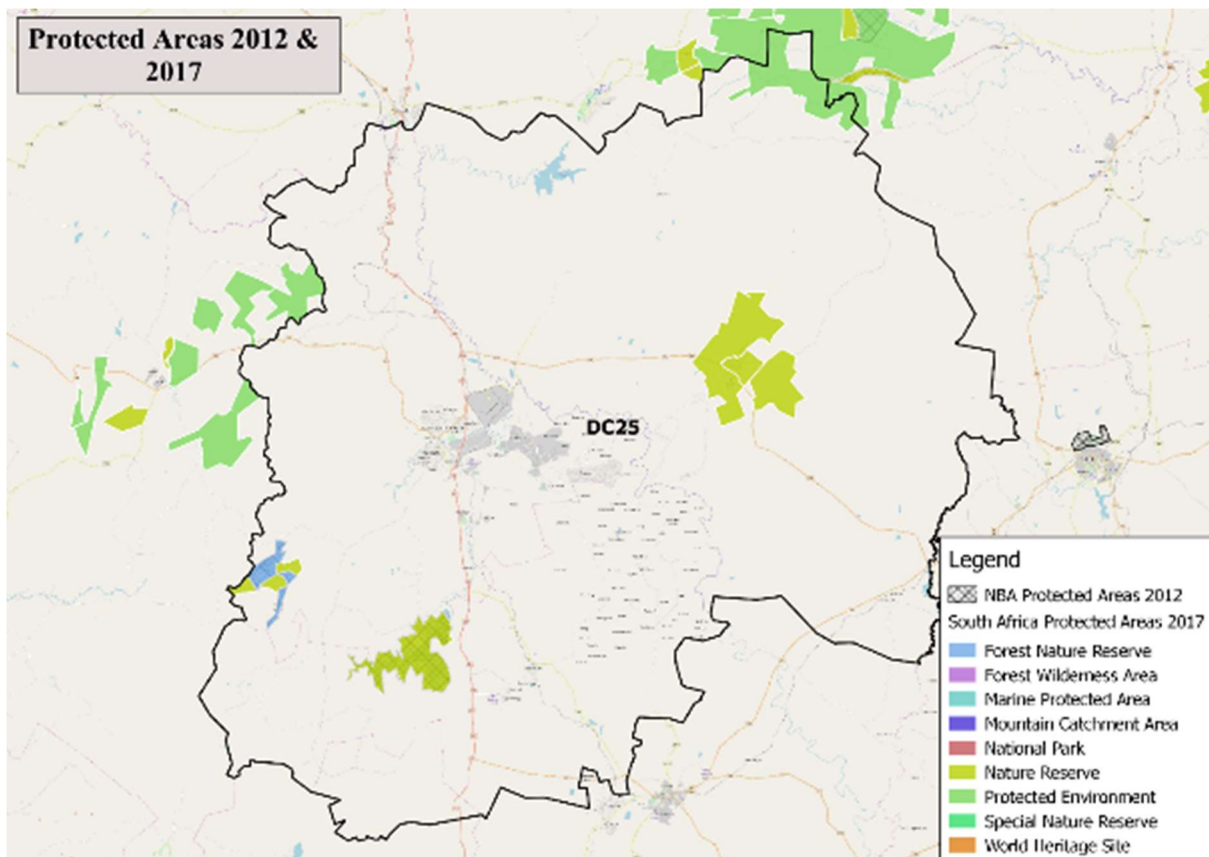


Figure 13: Protected areas in the District Municipal Area (South African National Parks / South African National Biodiversity Institute 2011; Department of Environmental Affairs 2017)

In South Africa 65% of wetlands are threatened, of which 48% are critically endangered, 12% are endangered and 5% are vulnerable (Driver, A. et al. 2012). Wetland degradation is caused by inter alia: poor land management practises, spatial developments near urban areas, the spread of invasive alien plants; agricultural practises, pollution and the building of dams (Driver, A. et al. 2012).

In the Amajuba District Municipal Area, the condition of most wetlands (Figure 14) is either 'mostly natural or good' (more than 75% of the wetland land cover is natural) or 'moderately modified' (between 25% and 75% of the wetland land cover is natural) (Council for Scientific and Industrial Research 2011). Some wetlands are categorised as 'heavily to critically modified' (less than 25% of the wetland land cover is natural). These 'heavily to critically modified' wetlands mostly occur in or around dams or urban areas.

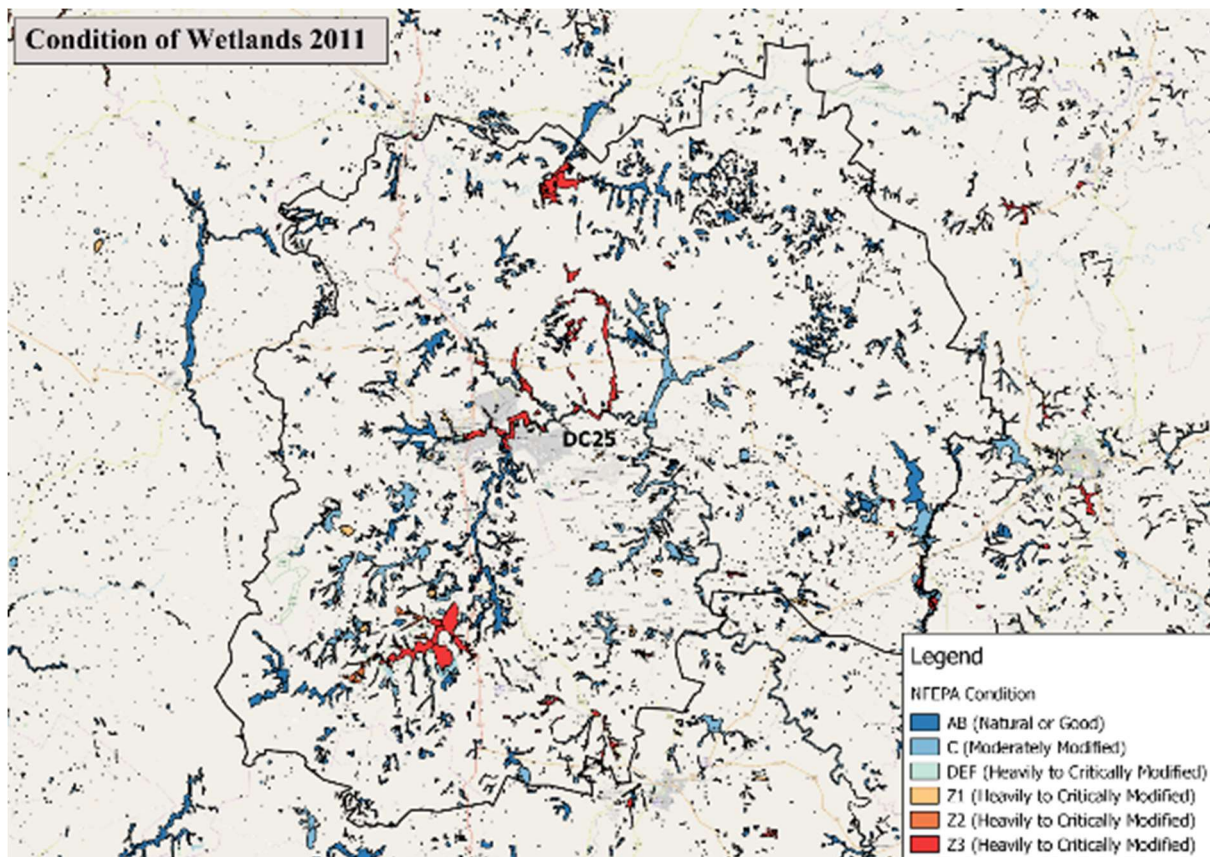


Figure 14: Condition of wetlands in the District Municipal Area (Council for Scientific and Industrial Research 2011)

Land-use in the Amajuba District Municipal Area is split between commercial farming, forestry, mining, Traditional Authority areas (including subsistence farming), conservation areas and several small urban areas (Amajuba District Municipality 2016a). These land uses have had varying effects on the biodiversity of the Amajuba District Municipal Area.

Biodiversity in the Amajuba District Municipal Area has been positively influenced by the conservation areas. It has been negatively influenced by inter alia: land degradation including soil erosion (mainly due to overgrazing and poor land management practises), wetland degradation, unsustainable harvesting of natural resources, unregulated veld burning, unsuitable agriculture and forestry developments, the spread of invasive alien species, increased pollution, poor waste management, population growth, spatial development (such as the expansion of agricultural and urban areas), and an extended drought that has affected most of KwaZulu-Natal since 2015 (Amajuba District Municipality 2016a). The land and wetland degradation have also raised the flood risk to low-lying areas in the Amajuba District Municipality (Amajuba District Municipality 2016a).

According to the Millennium Ecosystem Assessment (2005) ecosystem services are “the benefits that people obtain from ecosystems”, which can be divided into four categories: provisioning (e.g. timber), supporting (e.g. nutrient recycling), regulating (e.g. water purification), cultural (e.g. recreational activities) (Millennium Ecosystem Assessment 2005). The existing challenges that negatively affect the biodiversity in the Amajuba District Municipal Area (discussed above) have also reduced ecosystem services (particularly provisioning services and regulating services) in the Amajuba District Municipal Area and will continue to do so, if these impacts are not reduced. Furthermore, it is predicted that climate change will exacerbate these challenges and their effects on the biodiversity and related ecosystem services in the Amajuba District Municipal Area (Amajuba District Municipality 2016a).

If the biodiversity and related ecosystem services in the Amajuba District Municipal Area are badly reduced, it could have direct negative consequences for the economy and social structures in the Amajuba District Municipality. These consequences could have a detrimental effect on efforts to reduce poverty, inequity and unemployment in the Amajuba District Municipal Area.

4.4 Amajuba DM Health Sector Summary

A great proportion (82.4 %) of South Africa's population are dependent on the public health sector for health related services of which there are 3,880 public facilities (Health Systems Trust 2012). These public facilities are divided into two main groups: 3,487 primary health care facilities (consisting of 3,074 clinics; 238 community health centres; 125 satellite clinics; 44 community day centres; four specialised clinics and two health posts) and 391 hospitals (of which six are central hospitals; 10 tertiary; 55 regional; 254 district and 66 specialised hospitals) (Health Systems Trust 2012). Of the above, 25 clinics, one community health centre, one district hospital and two regional hospitals fall within the Amajuba District Municipal Area (Massyn et al. 2016).

According to a health care facilities audit by the Health Systems Trust, the Amajuba District Municipal Area received a score of 57 % on vital measures in the six ministerial priority areas for health care facilities and 72 % for the infrastructure of health facilities (Health Systems Trust 2012). The score on vital measures in the six ministerial priority areas relates to patient-centred care, specifically focusing on: positive and caring attitudes; waiting times; cleanliness; patient safety; infection prevention and control; and availability of medicines and supplies (Health Systems Trust 2012). The infrastructure score meanwhile is based on the assessment of mainly: building and site infrastructure, facility infrastructure management and standards around the availability of space (Health Systems Trust 2012).

The total population of the Amajuba District Municipal Area was approximately 499,839 people in 2011 (Statistics South Africa 2011). The District Municipal Area is youthful, with children under the age of 15 making up 33.69 % of the total population, while those aged between 15 and 39 account for a further 42.95 % (Statistics South Africa 2011). Furthermore, the 40 to 64 age group makes up 18.71 % of the population and the elderly (>64yrs age group) make up the remaining 4.66 % of the population (Statistics South Africa 2011). Furthermore, the young (<5yrs age group) and elderly (>64yrs age group) constitute 16.38 % of the total population (Figure 15) (Statistics South Africa 2011). These two groups are said to be the most vulnerable to climate change impacts. The darker areas on the map (Figure 15) indicate higher percentages of young and elderly people.

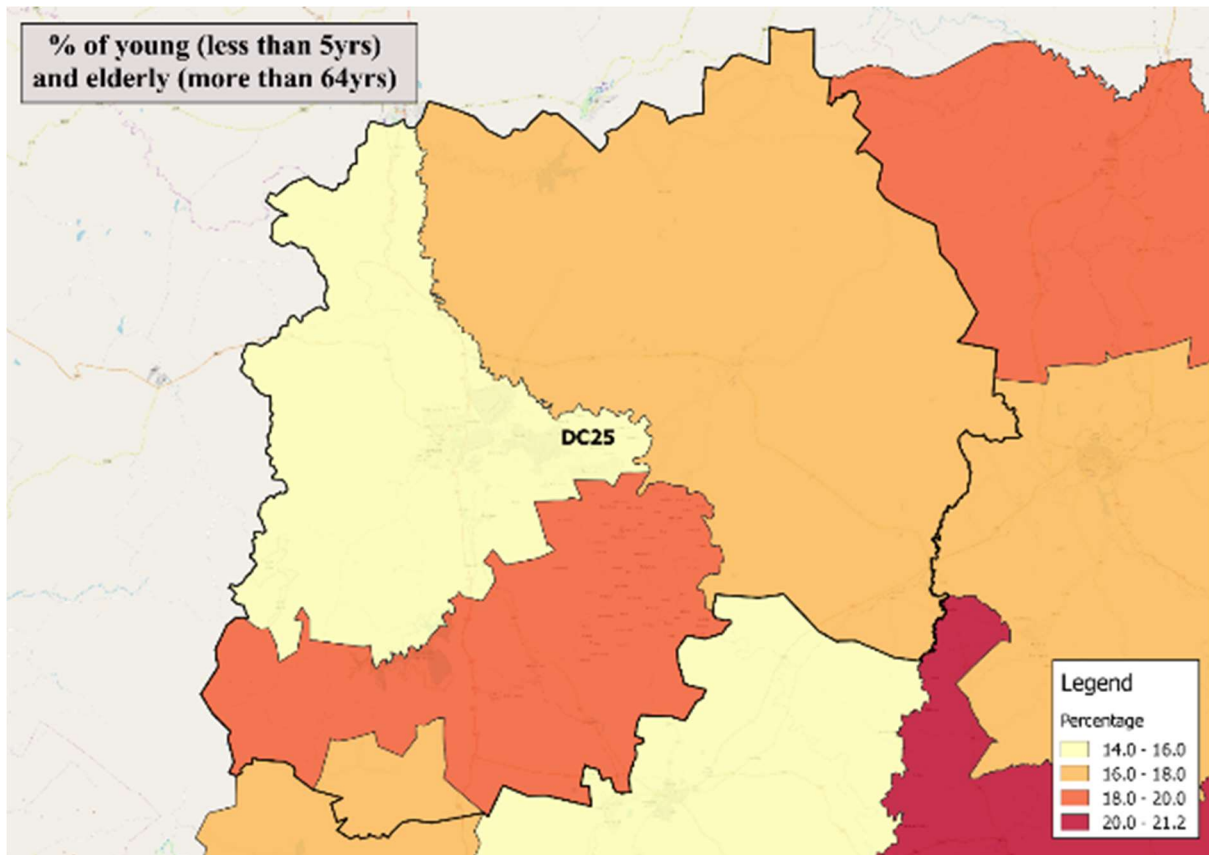


Figure 15: Percentage of young (<5yrs age group) and elderly (>64yrs age group) across the District Municipal Area (Statistics South Africa 2011)

In 2015, the total number of deaths in South Africa was 460,236, of which 4,765 occurred in the Amajuba District Municipal Area (Statistics South Africa 2015). The distribution of deaths by age for South Africa revealed that in, 2015, 7 % of the deaths occurred in children under the age of five, while individuals over the age of 64 accounted for 34.4 % of the deaths (Statistics South Africa 2015).

In 2015, the top ten underlying natural causes of death within the Amajuba District Municipal Area were: tuberculosis; other forms of heart diseases; cerebrovascular diseases; diabetes mellitus; other viral diseases; HIV; hypertensive diseases; influenza and pneumonia; other acute lower respiratory infections; and intestinal infectious diseases (Statistics South Africa 2015).

Specifically, the leading causes of death for children under five years of age, for the 2009 to 2014 period, in the Amajuba District Municipal Area were a group of communicable (infectious) diseases together with perinatal, maternal and nutritional conditions (Massyn et al. 2016). Diarrhoeal diseases (20.6 %) were the leading cause of children's (<5yrs age group) deaths, followed by lower respiratory infections, which accounted for 20.4 % of deaths (Massyn et al. 2016).

Additionally, the leading causes of death for the elderly (>64yrs age group) in the Amajuba District Municipal Area were a group of non-communicable diseases (which cannot be transferred from one person to the next) that accounted for 53.9 % of the deaths between 2009 and 2014 (Massyn et al. 2016). Of these non-communicable diseases, cerebrovascular disease was the leading cause (18.6 %) of deaths, followed by hypertensive heart disease (12.9 %) (Massyn et al. 2016).

With regards to specific non-communicable diseases for 2015/2016, the number of newly diagnosed cases of diabetes mellitus was approximately 0.8 occurrences per 1,000 people in the Amajuba District Municipal Area (Massyn et al. 2016). Additionally, the number of newly diagnosed cases of

hypertension in 2015/2016 was approximately 13.6 occurrences (in people over the age of 40) per 1,000 people in the District Municipal Area (Massyn et al. 2016).

Furthermore, in the Amajuba District Municipal Area between 2009 and 2014, meningitis/encephalitis was ranked as the 7th most common cause of death in the age group 5 to 14 years old, accounting for 4.5 % deaths in this age group (Massyn et al. 2016). It was also ranked the 8th most common cause of death in the age group 15 to 24 years old, accounting for 3.6 % of deaths in this age group, and was ranked the 8th most common cause of death in the age group 25 to 64 years old, responsible for 2.6 % of deaths of adults in this age group (Massyn et al. 2016).

Concerning waterborne and communicable diseases, approximately 18.76 % of the Amajuba District Municipal Area's households do not source water from piped water schemes (Statistics South Africa 2011) and are therefore vulnerable to waterborne diseases. For the "children under five years diarrhoea case fatality" (that is children under five years who died in hospital from diarrhoeal disease) the District Municipal Area ranked 15th (where 1st represents the best performance and 52nd represents the worst performance in South Africa) with a diarrhoea case fatality rate of 1.3 % during the 2015/16 period (Massyn et al. 2016). The national average for "children under five years diarrhoea case fatality" was 2.2 % over the same time period (Massyn et al. 2016).

Furthermore, for the "Child under 5 years severe acute malnutrition case fatality rate" (that is children under five years who died from acute malnutrition) the Amajuba District Municipal Area ranks 16th (where 1st represents the best performance and 52nd represents the worst performance in South Africa) with a rate of 6.5 % during the 2015/16 period (Massyn et al. 2016). This is below the national average of 8.9 % over the same time period (Massyn et al. 2016).

In terms of risks posed by working conditions, about 25.84 % of the Amajuba District Municipal Area's economically active population are employed, of which roughly 15.6 % are employed within the informal sector (Statistics South Africa 2011). Many of the people employed in the informal sector work outdoors in poor conditions, with limited infrastructure and services such as shade, and limited access to amenities such as water and sanitation (Statistics South Africa 2011).

Additionally, 35.97 % of the Amajuba District Municipal Area's households are involved in agricultural activities (Statistics South Africa 2011). People who work outdoors, like those involved in agricultural activities, are especially vulnerable to the impacts of extreme weather conditions. Moreover, climate change is forecast to exacerbate the frequency and severity of extreme weather events (Department of Environmental Affairs 2013c). Consequently, predicted impacts for households involved in agriculture include reduced agricultural yields and water security as well as increased food insecurity.

Climate change impacts affect the social and environmental determinants of health which include clean air, secure shelter, safe drinking water, and sufficient food (World Health Organization 2017). Below are some general climate change manifestations and their associated impacts on human health.

- Natural disasters - The frequency and severity of natural disasters has increased. Natural disasters destroy health facilities and homes. People may be forced to vacate their properties leading to increased risk to a wide range of health effects including communicable diseases and mental disorders (World Health Organization 2017).
- Increased storm events - These affect the supply of fresh water consequently increasing the risk of diarrhoeal diseases (World Health Organization 2017).

- Floods - The frequency and intensity of floods has increased. Floods pollute water supplies and increase the risk of water borne diseases. In addition, people lose their life's as a result of drowning or physical injuries, property is damaged and the supply of health services is disrupted (World Health Organization 2017). Climate change will also impact the distribution and causes of several communicable diseases including cold-influenza and dry-meningococcal meningitis among others (Singh and Kistnasamy 2014).
- Changes in climate conditions also affect vector-borne diseases that are transported through organisms such as snails, insects and other cold-blooded animals (World Health Organization 2017). With climate change the transmission season will lengthen and the geographic range of some vector borne diseases will change (World Health Organization 2017).
- Increased temperatures and variable rainfall are likely to reduce agricultural yields consequently increasing the prevalence of malnutrition and hunger as a result of food insecurity (World Health Organization 2017).
- Increased heat stress leads to death which can be attributed to cardiovascular and respiratory diseases (World Health Organization 2017).
- Increased air pollution and increased occupational health problems (World Health Organization 2017).

The main disaster risks that are likely to affect human health in the Amajuba District Municipal Area are veld fires, structural fires, drought, lightning, strong winds, hailstorms, heavy rain and floods (Amajuba District Municipality 2016b). It is predicted that these disasters will be exacerbated by climate change (Amajuba District Municipality 2016b).

From the information above, the predicted impacts of climate change on human health and health services are mostly negative. Hence, there is a need for climate change adaptation (and mitigation) to limit the negative impacts and encourage any positive effects of climate change on human health in the Amajuba District Municipal Area.

4.5 Amajuba DM Human Settlements Sector Summary

The Amajuba District Municipality has a total population of 499,839 people over a 6,911 km² area (72.3 people per square kilometre) with majority of the population (73.47%) under the age of 39 (Statistics South Africa 2011). Almost half (49.50%) of the working-age population (those aged 15 to 64) are currently not economically active (Figure 16), which is approximately 10.29% higher than the South African average (Statistics South Africa 2011). Amongst the 25.84% of the working-age population who are employed, 15.53% of this workforce are involved in the informal sector (Statistics South Africa 2011). Additionally, the unemployed constitute 16.56% of the working-age population, while the remaining 8.10% are discouraged work-seekers (Figure 16) (Statistics South Africa 2011).

Regarding education levels in the District Municipal Area, 30.47% of the population have attained a matric, 7.53% of the population have earned a post-school qualification, 31.15% of the population have some secondary schooling, and 18.54% have some or completed primary schooling (Statistics South Africa 2011). The remaining 12.31% have been classified as “other” in terms of their level of education (Statistics South Africa 2011).

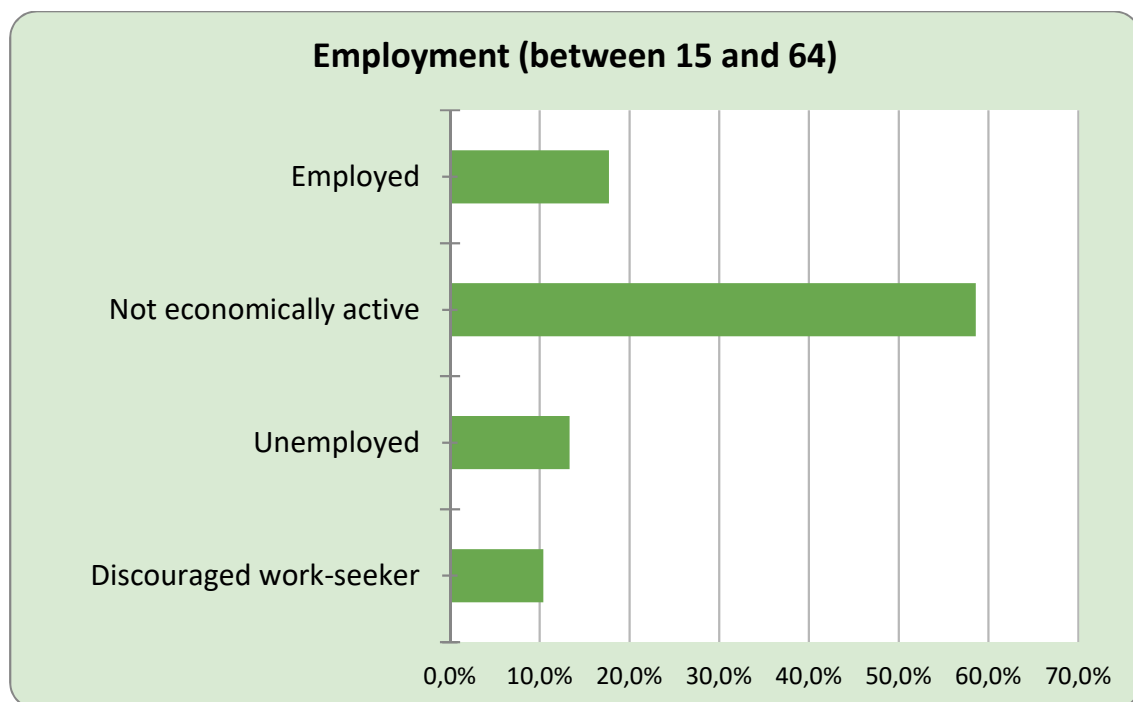


Figure 16: Employment status in the District Municipal Area (Statistics South Africa, 2011)

Most parts of the Amajuba Municipal District are farmlands with traditional land-use patterns that have evolved from various influences (Amajuba District Municipality 2013). Land uses that exist within the Municipal District include urban settlements (such as the Newcastle urban complex and small towns within the Emadlangeni and Dannhgauser Local Municipalities), rural settlements (which primarily include subsistence agriculture, which generates limited economic value), as well as privately-owned commercial agriculture developments, and conservation areas (Amajuba District Municipality 2013).

There are 110,967 households in the Amajuba Municipal District with 87.10% of these dwellings in the form of a formal house¹ (Statistics South Africa 2011). The average household size in the District is 4.50 people per household (Statistics South Africa 2011). Additionally, 11.75% of the dwellings in the Municipal District (Figure 17) are either informal or traditional structures² that often exist without extensive service delivery or infrastructure, therefore increasing the occupant’s vulnerability to future climatic variations (Statistics South Africa 2011).

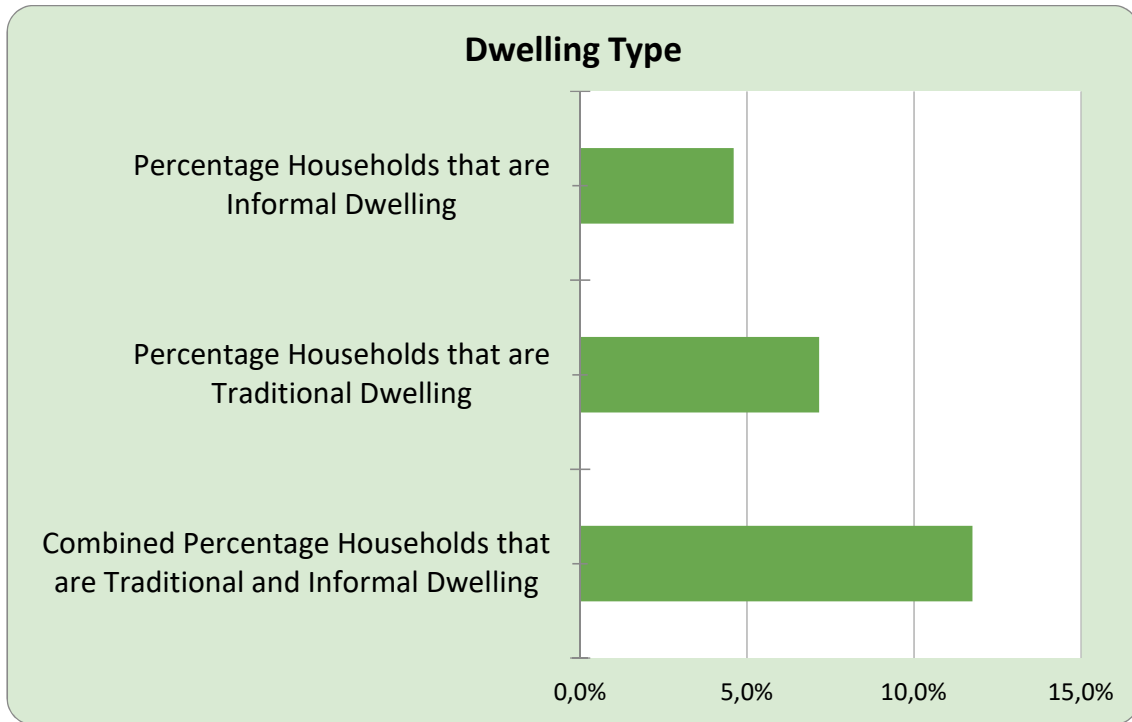


Figure 17: Households by type of dwelling in the District Municipal Area (Statistics South Africa, 2011)

Eskom is the main supplier of electricity within the District, although the Newcastle and Emadlangeni Local Municipalities have the licences to supply electricity in certain areas within their jurisdiction (Amajuba District Municipality 2017). The Amajuba District Municipality is in the process of completing its Electricity Supply Development Plan (ESDP) with the purpose of formulating a rational basis for extending grid and non-grid electricity service supply to the entire population with the District Municipality (Amajuba District Municipality 2017). However, approximately 25.24% of the households within the District Municipal Area use alternatives to electricity for cooking, while 15.37% use alternatives to electricity for cooking, heating and lighting (Statistics South Africa 2011).

A sizable portion of the population (81.28%) source water from the relevant service provider with only a small number of individuals using boreholes (0.65%) or water tanks (4.73%) for their water provision (Figure 18) (Statistics South Africa 2011).

Regarding sanitation services (Figure 19), 44.41% of the population have access to flush toilets, while 42.43% make use of pit latrines (Statistics South Africa 2011). The remaining individuals either have no access to toilets or make use of other toilet facilities.

¹ “Formal House” includes cluster houses, flat or apartment, house/flat/room in backyards, house or brick/concrete block structure on a separate stand or yard or on a farm, room/flatlet on a property or larger dwelling/servant’s quarters/granny flat and semi-detached houses

² “Traditional Structure” includes dwelling/hut/structure made of traditional materials

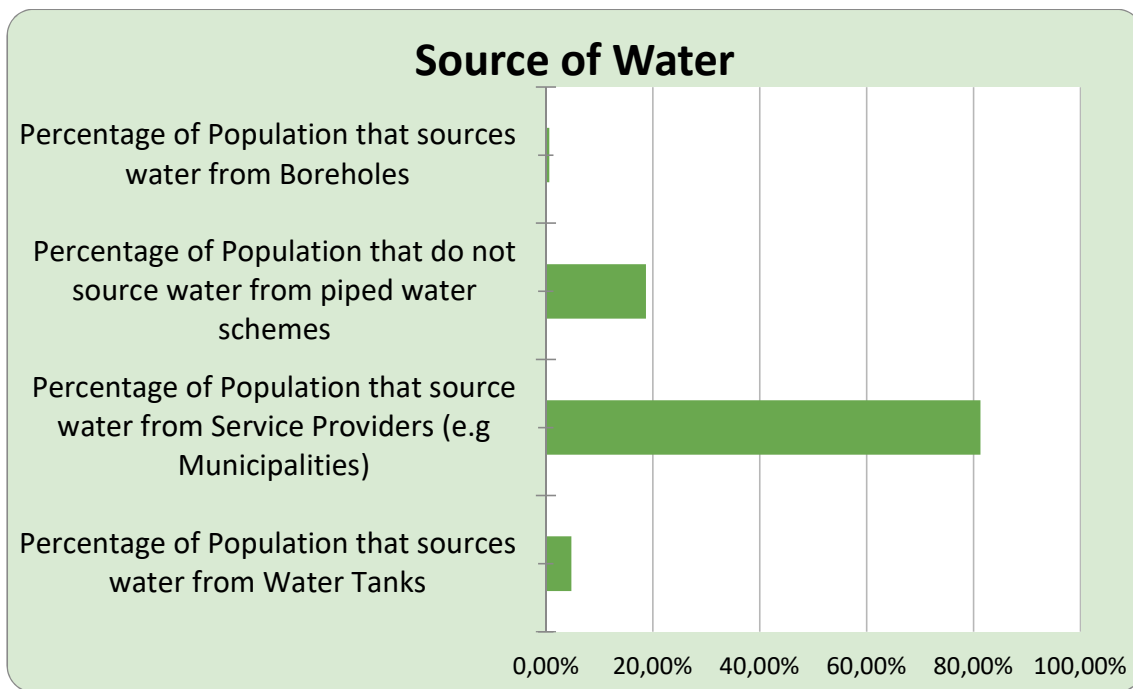


Figure 18: Household water sources in the District Municipal Area (Statistics South Africa 2011)

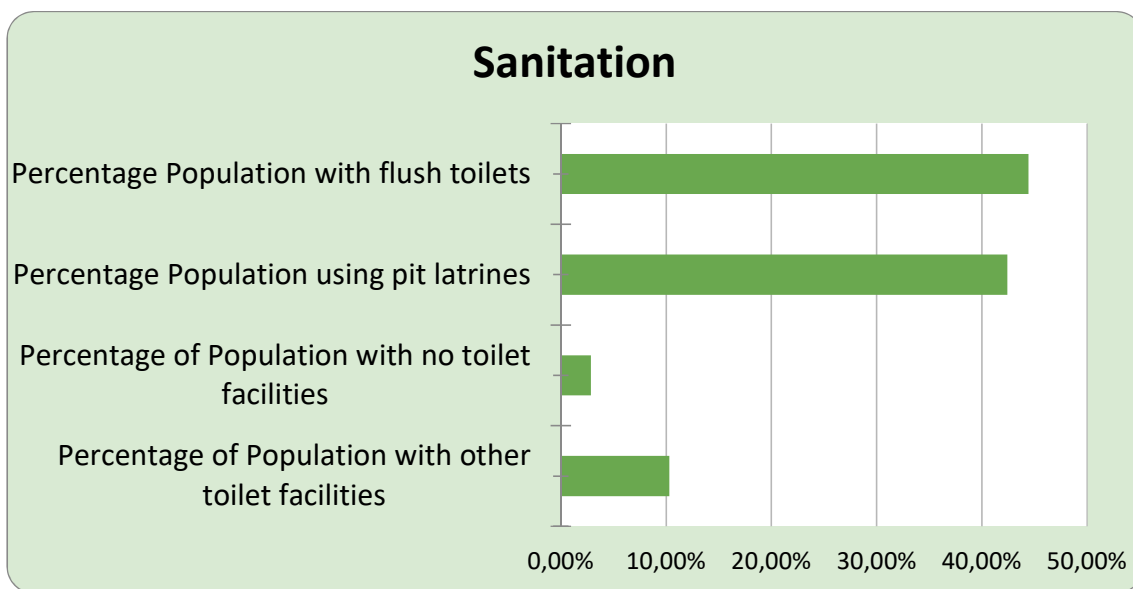


Figure 19: Sanitation facilities in the District Municipal Area (Statistics South Africa 2011)

In terms of strategic infrastructure, there are no airports in the Amajuba District Municipality although there is a minor airfield near the industrial area within the Newcastle Local Municipality the needs to upgraded (Department of Cooperative Government and Traditional Affairs nd). Upgrading this category two airfield into an airport could help promote the export success of companies located in the District by providing passenger and freight links to key markets (Department of Cooperative Government and Traditional Affairs nd). Additionally, the main freight rail link between Gauteng and Durban passes through the town of Newcastle, however no commuter rail service exists at this current time due to the location of the Newcastle train station in relation to the actual residential and employment areas in Newcastle (Department of Cooperative Government and Traditional Affairs nd).

The main transportation routes linking the District Municipality to its surroundings include the N11 (the alternative route between Durban and Johannesburg) as well as the R34 which provides linkage between the port city of Richards Bay with the interior of South Africa (Amajuba District Municipality 2017).

The Amajuba District Municipality is aware that human settlements are continuously transforming and acknowledges the importance of achieving sustainability, as changes in the climate may drastically impact human settlements in the future (Amajuba District Municipality 2017). With a large agricultural sector, variations in climate and water supply could affect production yields in the District and ultimately inhibit access to food (especially for subsistence farmers) as well as income for agriculture-reliant households.

As climatic changes increase average temperatures and rainfall variability (such as extended periods of drought), human settlements may express a higher demand for cooling appliances and access to water (Department of Environmental Affairs 2015). Additionally, contrasting extreme weather (such as severe storms and flash floods) may induce the displacement of people and settlements, increase public health risks, and escalate pressures on rural and urban infrastructure and transport systems (Department of Environmental Affairs 2015).

Major climatic risks in the District Municipal Area include: drought, floods, severe storms (wind, hail, lightning) and veld fire hazards (Amajuba District Municipality 2017). Regarding veld fires specifically, the entire District Municipal Area has an extreme veld fire risk (Figure 20) (Department of Agriculture, Forestry and Fisheries 2010).

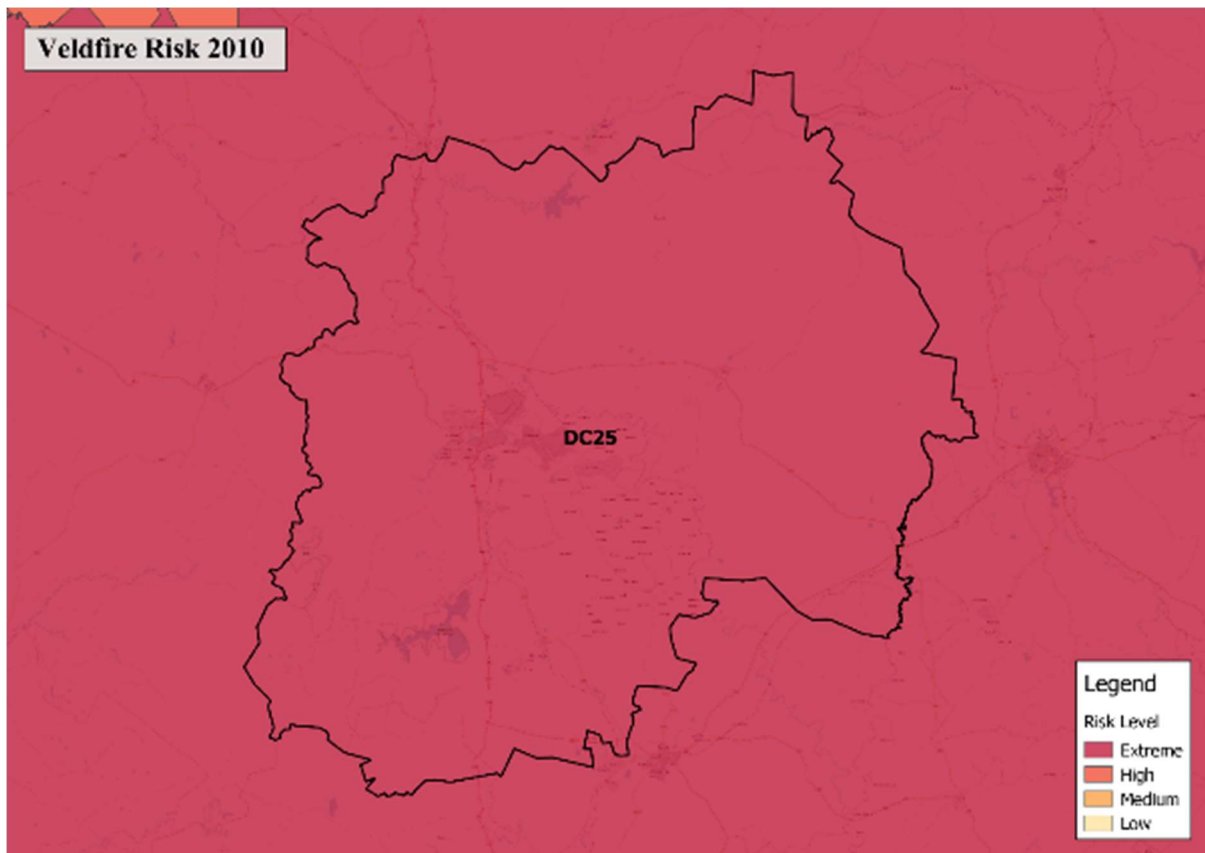


Figure 20: Veld fire risk for District Municipal Area (Department of Agriculture, Forestry and Fisheries 2010).

4.6 Amajuba DM Water Sector Summary

The Amajuba District Municipality falls under the Pongola-uMzimkhulu hydrological zone (Figure 21) (Department of Environmental Affairs 2013d). As outlined above (in Figure 1), in the warmer wetter future scenario, the Pongola-uMzimkhulu hydrological zone, and thus the Amajuba District Municipal Area, is likely to experience an increase in rainfall in spring (Department of Environmental Affairs 2013d). While in the hotter and drier scenario, the region will experience a decreased in rainfall in spring and a strong decrease in summer and autumn (Department of Environmental Affairs 2013d).

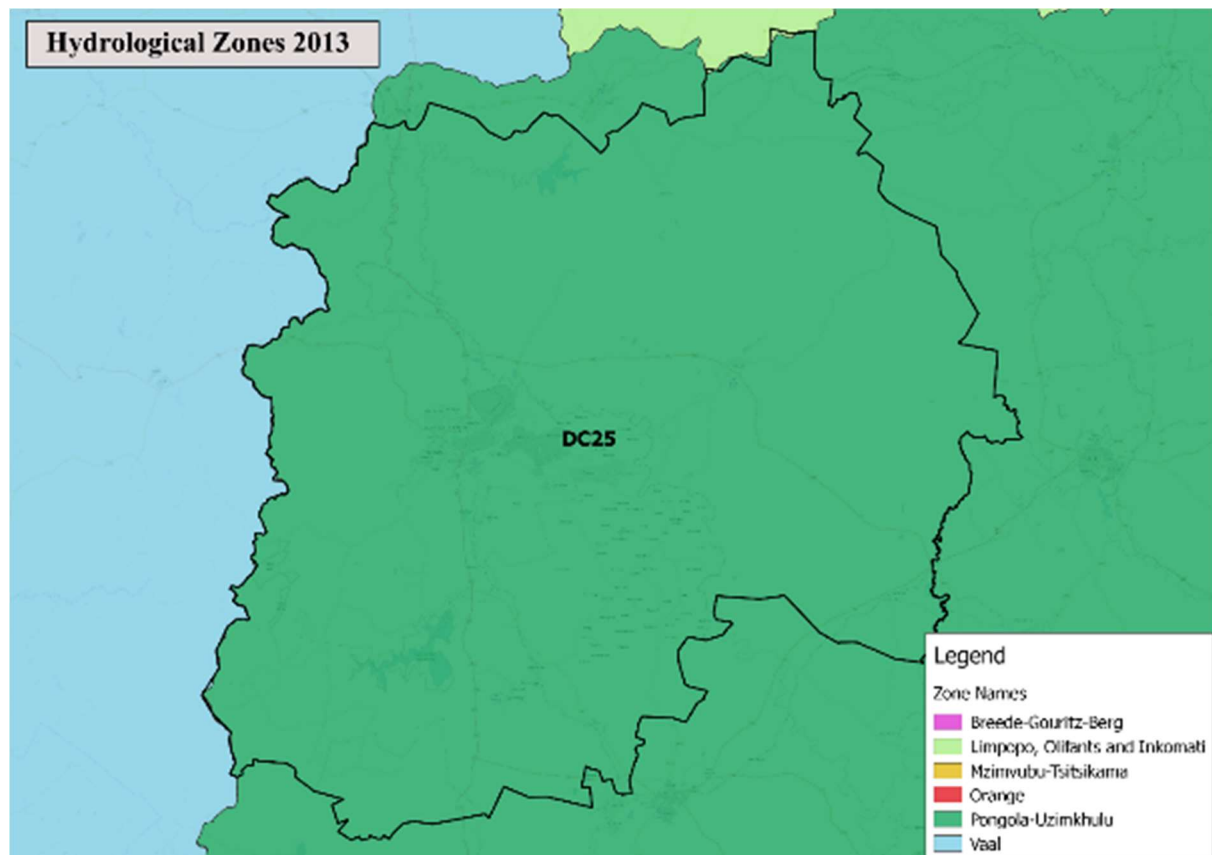


Figure 21: Hydrological Zone for the District Municipal Area (Department of Environmental Affairs 2013d)

The Amajuba District Municipality falls under the Pongola-uMzimkhulu Water Management Area (Figure 22) (Department of Environmental Affairs 2013d). Inside the Pongola-uMzimkhulu Water Management Area, the Amajuba District Municipal Area overlaps with five catchments, namely the Mfolozi, Mkuze, Pongola, Usuthu and Lake Sibaya catchments (Department of Water and Sanitation 2016). Within these catchments, the Amajuba District Municipal Area contains three main water resources: the Zaaihoek, Amcor, and Ntshingwayo Dams (Department of Water and Sanitation 2016). These water resources are evenly spread throughout the Amajuba District Municipal Area (Figure 23).

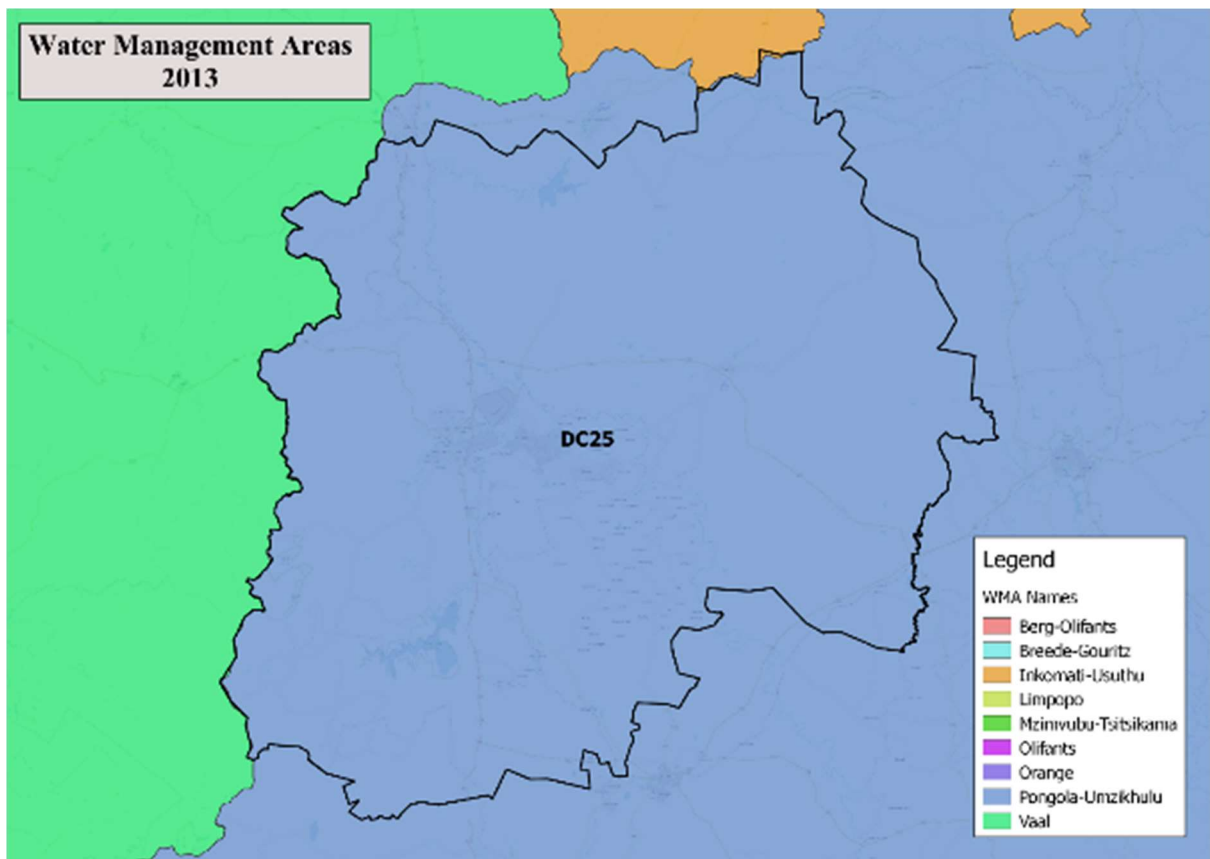


Figure 22: Water Management Area for the District Municipal Area (Department of Water Affairs 2013)

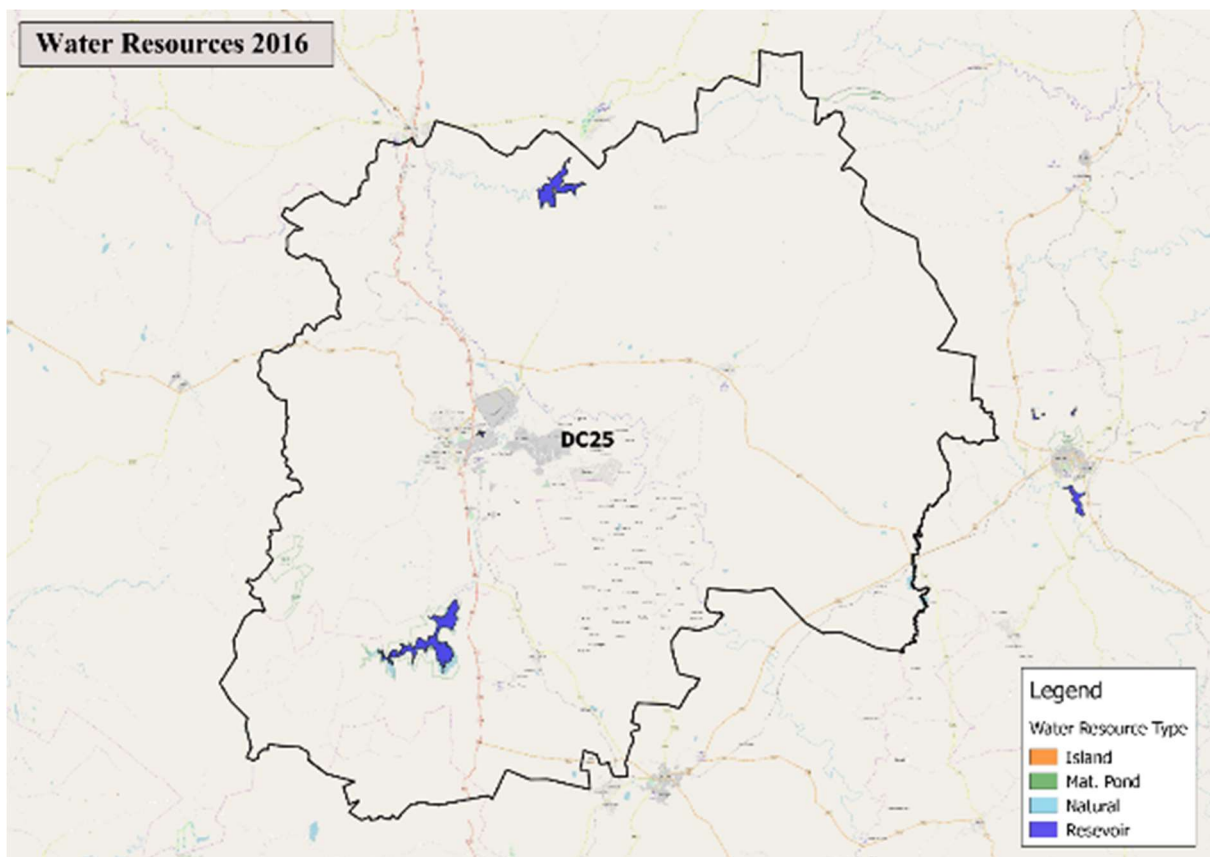


Figure 23: Water resources within the District Municipal Area (Department of Water and Sanitation 2016b)

The water quality in rivers within the Amajuba District Municipal Area is in a reasonably good state, which means that the rivers are able to contribute towards river ecosystem biodiversity targets (SANBI 2011). The health of a river system is graded into one of several categories (SANBI 2011). These categories are listed in Text Box 1.

Text Box 1: Freshwater Ecosystem Priority Areas (FEPAs) classification for river ecosystem conditions

River conditions in South Africa have been classified according to the Freshwater Ecosystem Priority Areas (FEPAs) for river ecosystems (SANBI 2011). The different grades are provided below:

A = Unmodified, Natural

B = Largely Natural with Few Modifications

Ab = A or B Above

C = Moderately Modified

D = Largely Modified

E = Seriously Modified

F = Critically/Extremely Modified

Ef = E or F Above

Z = Tributary Condition Modelled as Not Intact, According to Natural Land Cover

Rivers that are unmodified or in their natural state are able to contribute towards river ecosystems biodiversity targets (SANBI 2011). In contrast, rivers that are categorised as 'largely modified' or worse are unable to contribute towards river ecosystems as they are not in a good state.

Many of the rivers in the Amajuba District Municipal Area (Figure 24) such as the Pongola and Blood Rivers, are classified as 'Unmodified, Natural' (SANBI 2011). Additionally, certain sections of the Buffalo River as well as some smaller rivers such as the Tinya, Mbambane and Kweekspruit Rivers, are classified as 'moderately modified' (SANBI 2011). Another smaller river, the Ingangane River is classified as 'largely modified' (SANBI 2011).

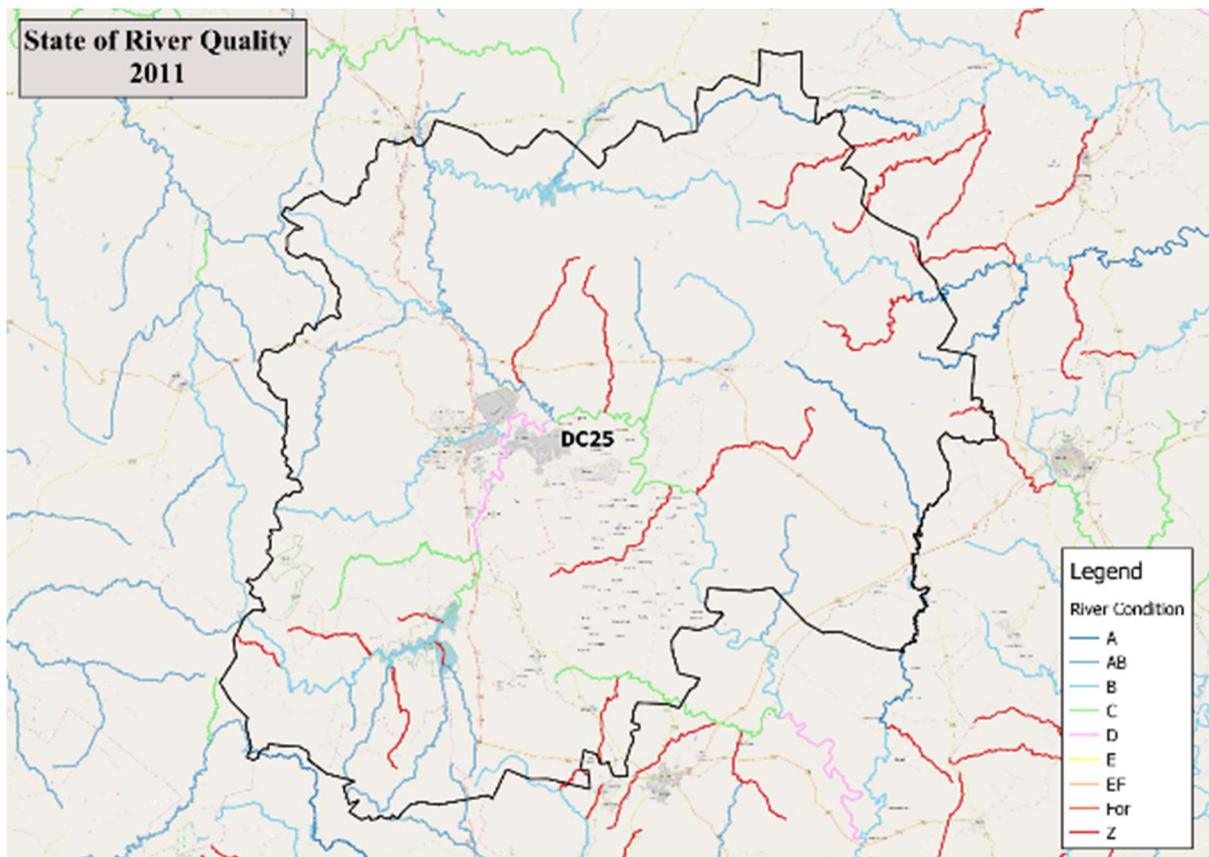


Figure 24: State of water quality in rivers in the District Municipal Area (SANBI 2011)

Water resources in any catchment are largely depended on rainfall. The Historical Climate Monthly Averages include long-term historical monthly average rainfall totals and monthly averaged minimum and maximum temperatures for a particular spot (Climate System Analysis Group 2017b). Due to the unavailability of weather data stations, the Historical Climate Monthly Averages for the Amajuba District Municipal Area have been calculated using the nearest weather data station to the Municipality, which is the measuring station at Newcastle (Figure 25). The graph (in Figure 25) shows that average temperatures peak in the same months as highest rainfall, indicating that the Amajuba District Municipal Area is in a summer rainfall area (Climate System Analysis Group 2017b). Resultantly, there is less rainfall during winter seasons with the lowest average monthly rainfall historically occurring in July, which averages less than 5 mm (Climate System Analysis Group 2017b).



Figure 25: Historical Climate Monthly Averages for Newcastle (Climate System Analysis Group 2017b)

Linked to the rainfall and rivers in the Amajuba District Municipal Area are the water and sanitation services. Specifically, a total of 18.72 % of households in the Amajuba District Municipal Area do not receive their water from piped water schemes, which is lower than the national average of 21.82 % (Statistics South Africa 2011). Additionally, according to the 2016 Stats SA Community Survey for the Amajuba District Municipal Area: 111,632 households have piped water supply either to inside the home or on site; 17 % of households are dependent on communal stand pipes; and, 7.9 % of households rely on boreholes or springs (Amajuba District Municipality 2016a). A concern is that the water quality of the boreholes and springs is unknown, and therefore poses a potential risk to the health of people relying on them (Amajuba District Municipality 2016a). Furthermore, the percentage of the population with flush toilets in the Amajuba District Municipal Area is 44.41 %, while the national average is 56.51 % (Statistics South Africa 2011). This indicates a lack of sanitation facilities within Amajuba District Municipality.

The Amajuba District Municipality in their 2016/2017 *Integrated Development Plan*, stated that a recent ward-level analysis found the Amajuba District Municipality to have unhygienic conditions due to the high number and poor condition of pit latrines in the Amajuba District Municipal Area (Amajuba District Municipality 2016a). These unhygienic conditions exacerbate the risk to human health for people living in the Amajuba District Municipal Area who depend on boreholes, springs, rivers and streams for their drinking water. The Amajuba District Municipality's 2016/2017 *Integrated Development Plan* also states that it has not been able to confirm whether all available and recorded water sources in the Amajuba District Municipal Area are of a suitable quality for human consumption (Amajuba District Municipality 2016a). The Amajuba District Municipality in their 2016/2017 *Integrated Development Plan* has identified these water and sanitation issues as challenges that needs to be addressed (Amajuba District Municipality 2016a).

Directly linked to water and sanitation services in the Amajuba District Municipal Area are the Blue and Green Drop scores. Blue Drop scores rate the quality of drinking water, while Green drop scores rate the quality of wastewater. Blue Drop scores rate the quality of drinking water supplied by water service providers. The Blue Drop score can be understood using the following scale: 90 – 100 % = 'Excellent situation'; 75 - <90 % = 'Good status'; 50 - <75 % = 'Average performance'; 33 - <50 % = 'Very poor performance'; and, 0 - <33 % = 'Critical status' (Department of Water Affairs 2011). The 2014 Blue Drop score for the Amajuba District Municipality was 58.00 %, indicating an 'average performance' (Department of Water and Sanitation 2014).

The Green Drop score rates the quality of wastewater management in municipalities. The Green Drop score can be understood using the following scale: 90 – 100 % = ‘Excellent situation’; 80 - <90 % = ‘Good status’; 50 - <80 % = ‘Average performance’; 30 - <50 % = ‘Very poor performance’; and, 0 - <30 % = ‘Critical state’ (Department of Water and Sanitation 2016a). The 2013 Green Drop score for Amajuba District Municipality was 60.36 % (Department of Water and Sanitation 2013). The Green Drop score indicates that the wastewater services in the Amajuba District Municipality are ‘average’ according to the expectations of the Department of Water and Sanitation as assessed by the Green Drop score.

In addition to an ‘average’ Green Drop score, 53.13 % of households have their refuse removed by local authority/private company in the Amajuba District Municipal Area (Statistics South Africa 2011). As the national average for household refuse removal is 59.40 %, this indicates a lack of resources in the Amajuba District Municipality (Statistics South Africa 2011). Uncollected waste often ends up in water and sanitation infrastructure, blocking stormwater drains and polluting rivers. It is predicted that climate change will affect these water and sanitation challenges.

Climate change is predicted to have an impact on rainfall patterns in South Africa. Future rainfall projections for the Amajuba District Municipality (using the measuring station at Newcastle) for the period 2020 to 2040 (Figure 26) are made using the Representative Concentration Pathways (RCP) 4.5 greenhouse gas concentration trajectories (Climate System Analysis Group 2017a).

The bar charts (Figure 26) show the potential change in rainfall, with the blue bars indicating a potential increase in average rainfall and the red bars indicate a potential decrease in average rainfall (Climate System Analysis Group 2017a). The grey lines represent the various models used for this projection. It is therefore projected across most of the models that Amajuba District Municipality could experience an increase in rainfall in the months of January, February, March, May, July, August, September, October, November and December, and a decrease in rainfall during April and June (Climate System Analysis Group 2017a).

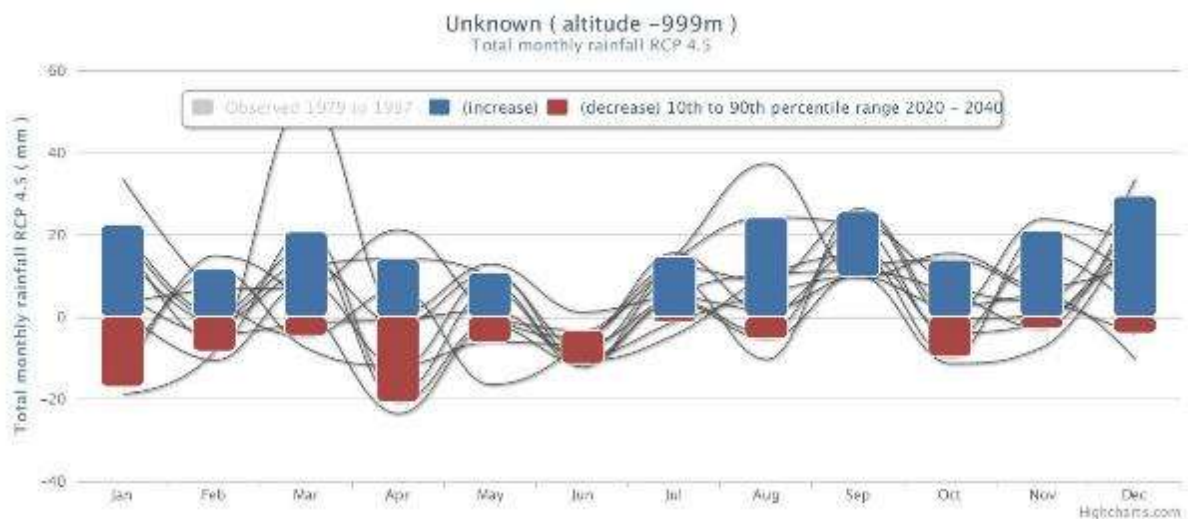


Figure 26: Rainfall Projections for Newcastle (Climate System Analysis Group 2017a)

5 Vulnerability Assessment Results

The following section provides a summary of the Vulnerability Assessment conducted for Amajuba District Municipality.

5.1 Agriculture

Table 4: Agriculture Vulnerability Indicator Table Amajuba District Municipality

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
1	Change in grain (maize, wheat & barley) production	Areas towards the west of RSA are likely to become less suitable for grain production.	Do you grow or have potential to grow grains in your area?	Yes	Commercial and subsistence maize growth in all local municipalities. There is minimal wheat growth in the District.	How important is grain to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	High	Maize is grown commercially and is an important grain in the District. High percentage of communities that depend on maize for staple food and some is fed to cattle. High percentage of grain is also grown on subsistence basis.	Medium	Low capacity for subsistence and small farmers but medium for commercial farmers. Commercial farmers have subsidies from government in the event of climatic changes. Research is there for commercial farmers in terms of drought resistant cultivars. Commercial farmer have better adaptive capacity, they are well organised. Subsistence

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
										farmers lack capacity in terms of finance and technical support. KZNDARD Amajuba DM Agri Master Plan Emadlangeni Agri Master Plan Follow up to be done with Mr Myeza -LED, Amajuba LED and Department of Agriculture.
2	Change in Sorghum production	Sorghum yields are projected to increase in parts of western KZN, inland areas of the Eastern Cape and the eastern Free State, with some areas in the north registering losses compared with present climatic conditions.	Do you grow or have potential to grow Sorghum in your area?	Yes	Small scale production in all three local municipalities.	How important is sorghum to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low			Amajuba DM Local Economic Development Strategy, KZNDARD, Grain SA
3	Change in Soya Bean Production	Areas in the east of RSA lost to potential production, with	Do you grow or have potential to grow Soya	Yes	Alternate crop in all three local municipalities	How important is soya bean to the local	High	Used as alternative crop (maize-soyabeans)		To follow up with Department of Agriculture

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		an expansion of suitable areas inland towards the central/west or RSA.	Bean in your area?			economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low				
4	Change in Sugarcane Production	Increase in <10% in many parts of the present cane growing areas, but by up to 30% in new growth areas further inland.	Do you grow or have potential to grow Sugarcane in your area?	Yes	Area suitable for sugarcane. Sugar mills are however, far from the area	How important is sugarcane to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low			Only challenge is infrastructure for agro processing.
5	Change in viticulture (grapes) production	Areas suitable for viticulture could be substantially reduced or shift to higher altitudes and currently cooler, more southerly locations.	Do you grow or have potential to grow grapes in your area?	No	Area not suitable for grapes	How important is viticulture (grapes) to the local economy and livelihoods? High Priority Crop = High; Medium				

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
						Priority Crop = Medium; Low /No Priority Crop = Low				
6	Change in fruit production	Projected reduction of the area suitable for fruit production (e.g. 28% reduction in apple and pears) by as early as 2020.	Do you grow or have potential to grow fruit in your area?	Yes	Citrus and stone fruits in all three local municipalities	How important is fruit to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low	Fruits are not commercially grown at a large scale within the district. Very few households grow them for subsistence use.		KZNDARD, Amajuba DM and all three local municipalities. Look at possibilities of growing more citrus in the area.
7	Change in other crop production areas (e.g. vegetables, nuts, etc.)	Crop production may vary depending on a warmer wetter or warmer drier climate.	Do you grow or have potential to grow other crops in your area?	Yes	Area is suitable due to soil type and climate conditions. Spinach, cabbage and potato.	How important are other crops to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	High	Both subsistence (livelihoods) and commercial	Low	Amajuba DM and other local municipalities. Low capacity more especially for subsistence farmers. This is a priority indicator.

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
8	Increased areas for commercial plantations	The total area suitable for commercial forestry plantations would increase along the eastern seaboard and adjacent areas.	Do you have or have potential for commercial forestry plantations in your area?	Yes	Area is suitable for plantations (Pines).	Is there capacity for commercial plantation expansion (water use licence, land availability, demand for plantation products)? High Potential for Expansion = High; Medium Potential for Expansion = Medium; Low/No Potential for Expansion = Low	Medium	There's not enough land to expand plantations. The District has a lot of mountainous areas.	Low	DAFF, Amajuba DM, Agriculture Master Plan, Amajuba DM LED Strategy
9	Increased exposure to pests such as eldana, chilo and codling moth	Exposure to eldana would increase in areas suitable for sugarcane by ~10% to > 30%. The area subject to damage by chilo would increase substantially (sugarcane). The	Are you or will you be exposed to agricultural pests in your area?	Yes	Warm and wet summers increase pest infestation in all local municipalities. Farmers affected by Armyworm recently.	How important are crops that are vulnerable to pests to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop	High	Lots of subsistence farmers are affected by these. Warm temperatures are exacerbating pest infestation for grains and vegetables.	Medium	Medium in terms of research and policy. No local institutions focussing on pest control. Subsistence farmers are more vulnerable. KZNDARD,

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		area subject to damage by codling moth would increase substantially (apples, pears, walnuts and quince).				= Medium; Low/No Priority Crop = Low				ADM Agriculture Masterplan.
10	Increased risks to livestock	Projected decreases in rainfall and hence herbage yields would result in negative health impacts for livestock.	Do you or will you have livestock in your area?	Yes	All three local municipalities more especially Emadlangeni as it is known for beef farming	How important is livestock farming to the local economy and livelihoods? High Priority = High; Medium Priority = Medium; Low/No Priority = Low	High	Beef produced brings in income for the District and provides jobs and sustains livelihoods.	Low	Low capacity for subsistence farmers in particular. Climate change will negatively affect livestock farming. Grassland is threatened by savannah encroachment, grassland is vital for animal feed. This is a priority indicator. KZNDARD, Beef SA, ADM Agriculture Master Plan
11	Reduced food security	Reduced food security, particularly of subsistence farmers, and	Do you or will you have food insecurity in your area?	Yes	In all three municipalities	Percentage households involved in agricultural activities More than	High	About 35.9% of households are dependent on agricultural services/activities	Low	There is a need to promote LED especially in rural areas. There is a need to provide and

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		resultant increase in malnutrition.				20% = High; Between 20% & 10% = Medium; Less than 10% = Low				teach about drought resistant varieties in terms of grains and vegetables. This is a priority indicator. DARD (Food security programs) DSD, ADM, DRDLR (plans to enhance livelihoods)

5.2 Biodiversity and Environment

Table 5: Biodiversity Vulnerability Indicator Table Amajuba District Municipality

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
12	Loss of High Priority Biomes	High Priority Biomes (including Grasslands, Nama-Karoo, Indian Ocean Coastal Belt, Fynbos, Forest) to be replaced by other biomes such as savanna and desert.	Do you currently have high priority biomes in your area?	Yes	Grassland (Emkangala grassland project in Emadlangeni)	How much of this High Priority Biome will be lost due to climate change? A significant amount= High; A moderate amount= Medium; None/a low amount = Low	High	The District Municipality is covered by grassland however this biome will be replaced by savanna.	Medium	There are policies and plans in place but implementation could be improved. Permitting system to regulate development in biomes. Capacitating communities, farmers on biodiversity. Ezemvelo KZN Wildlife, WWF, KZN EDTEA, Amajuba Biodiversity Sector Plan NGOs- Endangered Wildlife Trust
13	Increased impacts on threatened ecosystems	Loss of threatened ecosystems due to changes in climate.	Do you currently have threatened ecosystems in your area? (Classified as	Yes	Enkangala grassland is endangered. Paulpietersberg moist grassland-vulnerable.	How much of your Municipality is covered by threatened ecosystems?	High	The identified species are classified under TOPS as per NEMBA.	Medium	Scientific research is conducted Policies such as NEMBA are implemented.

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
			critically endangered, endangered or vulnerable)		Endangered crane species- blue crane, grey crowned crane, wattled crane.	A significant amount= High; A moderate amount= Medium; None/a low amount = Low				There is external funding from NGOs to implement conservation programmes within the District. Continuous awareness campaigns could be improved. Ezemvelo KZN Wildlife, WWF, KZN EDTEA, Amajuba Biodiversity Sector Plan, Birdlife SA Endangered Wildlife Trust SANBI
14	Increased impacts on environment due to land-use change	Loss of biodiversity and degradation of natural habitat due to significant land use change (such as alien invasion, soil erosion and urbanisation) which impacts on ability to	Are you currently experiencing land use change?	Yes	Loss of high value/potential agricultural land to residential in all three local municipalities. Alien species invasion. Veldfires.	Have you experienced significant loss of habitat since 1990? Above 10% = High; Between 5-10% = Medium;	High	Land use changes due to high urbanisation and invasion of alien species on natural habitats. Veld Fires due to high fuel in grasslands.	Medium	There are regulatory tools in place to deal with veldfires and alien invasive species. There are programmes to capacitate communities and farmers on veld management

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		respond to climate change				Under 5%= Low				through Biodiversity Stewardship Programmes. There are however internal conflicts with communities regarding implementation of some projects. KZN Agricultural Development, COGTA Spatial; Planning, LM- SDF, ADM SDF, KZN EDTEA
15	Loss of Priority Wetlands and River ecosystems	Changes in rainfall patterns and temperature are likely to impact on wetlands and the ecosystem services they provide.	Do you have priority wetlands and river ecosystems in your area?	Yes	Blood River Vlei, Groenvlei, Head waters of Pongola River, Buffalo River. Boshoff Vlei	How important are wetlands and river ecosystems in providing ecosystem services in your Municipality? A significant amount= High; A moderate amount= Medium;	High	There are species classified under TOPS as per NEMBA, these species are highly dependent on wetlands as their natural habitat.	Medium	Environmental calendar events. Continuous challenges of developments on sensitive areas. Municipal IDPs, Working for Wetlands, Biodiversity Sector Plan, EKZN Wildlife, DWS

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
						None/a low amount = Low				

5.3 Human Health

Table 6: Health Vulnerability Indicator Table Amajuba District Municipality

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
21	Health impacts from increased storm events	Increased storms will result increased risk of drowning, injuries and population displacement impacts.	Are you or will you experience increased storm events in your area?	Yes	In all three local municipalities	How populated are areas vulnerable to storms events (e.g. flood zones)? Densely populated = High; Partially populated = Medium; Sparsely or not populated = Low	Low	Not related to population density but rather topography and geological conditions (for the majority this is low)	Medium	Capacity is mainly good, with some small groups experiencing low capacity. Pro-active early warning systems exist in vulnerable areas. SAWS, District Disaster Management Centre
22	Increased heat stress	Increases in average temperatures and extreme events (such as heat waves) are projected to induce heat stress, increase morbidity, and result in respiratory and cardiovascular diseases.	Are you or will you experience increased heat waves in your area?	Yes	In all three local municipalities, in 2015 and 2016 a heat wave was experienced.	Is there a high percentage of young and elderly in the area? More than 20% = high; Between 15% & 20% = Medium; Less than 15% = low	High	Age distribution varies greatly from community to community. Rural is high and some urban is low.	High	SAWS, District Disaster Management Centre, Department of Health Good health services-clinics and hospitals.

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
23	Increased vector borne diseases from spread of mosquitoes, ticks, sandflies, and blackflies	Vector borne diseases such as malaria is projected to spread within regions bordering current malaria areas, which are presently too cold for transmission.	Are vector borne diseases present or likely in your area?	Yes	In all three local municipalities. Likelihood of Malaria spreading to the area. Bilharzia	Are you in or neighbouring an area with vector borne diseases (e.g. malaria)? Already in a vector borne disease area = High; Neighbouring a vector borne disease area = Medium; Not near a vector borne disease area = Low	Low	Most vector borne diseases not 'endemic' there is some evidence of change in this regard. Not endemic for Malaria/yellow fever Bilharzia etc.		Department of Health, Private health practitioners MMS at ADM. Migrant labour aggravates statistics.
24	Increased water borne and communicable diseases (e.g. typhoid fever, cholera and hepatitis)	Favourable conditions for the incubation and transmission of waterborne diseases may be created by increasing air and water temperatures.	Are waterborne and communicable diseases present or likely in your area?	Yes	In all three local municipalities. Buffalo Flats. Enteric Disease.	Have you had an incidence of waterborne and communicable diseases (e.g. typhoid fever, cholera and hepatitis) in the past 3 years Yes = High: No = Low	High	Contamination of boreholes/artesian wells by pit latrines and cemeteries etc.	Medium	Department of Health, ADM, Water analysis research has been done at a District level.
25	Increased malnutrition and hunger as	Climate Change will affect food systems,	Do you or will you have food	Yes	There are regular	Child under 5 years severe acute	Medium	Sensitivity is currently due to socio-economic	High	KZNDARD, KZN Health, NGOs (e.g

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
	a result of food insecurity	compromising food availability, access and utilisation, leading to food insecurity (particularly of subsistence farmers).	insecurity in your area?		droughts in the District	malnutrition case fatality rate More than 10% = high; Between 5% & 10% = Medium; Less than 5% = low		circumstances rather than climate conditions.		Red Cross), DSD Operation Sukuma Sakhe (OSS) Nutrition programmes in schools etc
26	Increased air pollution	Health impacts in resulting from exposure to air pollutants include eye irritation, acute respiratory infection, chronic respiratory diseases and TB, and sometimes death.	Do you or will you have air pollution in your area?	Yes	Especially in Newcastle Local Municipality due to industries	Would you consider your area a high priority in terms of air pollution (e.g. SAAQIS Priority Areas)? Yes = High; Somewhat = Medium; No = Low	High	Seasonal conditions (low inversion levels in winter). Dust production and veldfires are aggravating factors	Medium	Consultative forum. Industrial sector is trying to reduce their air pollution. Use of fossil fuels and wood for household energy is however increasing. KZN EDTEA, ADM, Reports from industries
27	Increased Occupational health problems	Temperature is a common climatic factor that affects occupational health (for	Do people work outside or are in conditions that cannot be	Yes	Farm workers, Construction e.g road workers. Other field workers	Do a significant percentage of people work outside or are in conditions that cannot be	Medium	Mechanisation of agriculture has reduced manual labour by huge amount. Heat strokes	High	Chamber of Mines. Organised Agriculture - Farmers Union.

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		example, agricultural labourer's productivity) by causing heat stress and dehydration.	cooled in your area?			cooled? Significant = High; Some = Medium; Low/No = Low		happens but is not common		Department of Transport, Construction industry, Department of Labour.

5.4 Disaster Management, Infrastructure and Human Settlements

Table 7: Disaster Management, Infrastructure and Human Settlements Vulnerability Indicator Table Amajuba District Municipality

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
28	Loss of industrial and labour productivity	Direct impacts of weather on construction, electricity generation and other industries, resulting in loss of productivity.	Do you have industrial activities in your area?	Yes	Newcastle Local Municipality Construction, steel, coal mining, textiles. There is mining in Dannhauser	How significant is the Mining/Industrial/Manufacturing sector for the local economy? Significant = High; Somewhat = Medium; Low/No = Low	High	The communities within the DM are highly dependent on the industrial sector. Loss of the sector can and will result in increasing social ills due to unemployment and decrease in trade and investment.	Medium	Not sure of any research, there are structures existing (Chambers). Review of key strategies ie DGDP to align with national policies. No existing funding. Capacitation on LED initiatives is continuous. LED Strategy, IDP, PSEDS
29	Increased impacts on strategic infrastructure	Increased disruptions to key strategic infrastructure (e.g. WWTW, storm water, roads, rail,	Do you have strategic infrastructure in your area?	Yes	N11, R34, Airport, Railways	How important is this strategic infrastructure to the functioning of your municipality? Significant amount = High;	High	Community will be affected as they cannot commute to work or receive any	Medium	For major routes P543, R34, N11 there is funding available, structures are

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		bridges) as a result of extreme weather events.				Moderate amount = Medium; Minimal or no = Low		external emergency assistance if required. Infrastructure is a key tool in driving the economy and general movement of the population.		in place. Not aware of any research conducted. Policies and plans are in place. SANRAL, Local municipalities, ACSA (Newcastle Airport) DOT, IDP, Transnet
30	Increased impacts on traditional and informal dwellings	Increased risk of extreme weather events to already vulnerable traditional and informal dwellings, that are often unplanned, and without extensive service or	Do you have traditional and informal dwellings in your area?	Yes	In all three local municipalities	What percentage of households are in traditional and informal dwellings in your area? More than 15% = high; Between 15% & 10% = Medium; Less than 10% = low	High	Loss of houses, loss of goods, exposure to health risks. Existing housing backlog can delay community from benefiting from RDP housing.	Medium	Newcastle LM. Temporal housing-wendy houses by PDMC. STATSSA, SDF and IDP and GIS, Department of Human Settlement

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		infrastructure .								
31	Increased isolation of rural communities	Physical isolation of rural communities as a result poor rural roads and increased flooding and erosion.	Do you have isolated rural communities in your area?	Yes	In all three local municipalities	Is your area predominantly Rural? Mostly Rural = High Equally Urban and Rural = Medium Mostly Urban = Low	Medium	Most of the population resides in the NLM with ELM and DLM with lower numbers. Emergency resources are mostly located in the NLM.	Medium	DOT, Local municipalities, Public Works, Rural Development
32	Increased migration to urban and peri-urban areas	Increased migration from rural settlements to urban and peri-urban settlements.	Do you have rural urban migration in your area?	Yes	All three local municipalities, Intra and inter municipal movement	Is there a strong rural economy? Low opportunities in rural areas = High; Some opportunities in rural areas = Medium; Strong rural economy = Low	Medium	There are agricultural and mining activities causing movement around the District	Low	Migration Plan to be developed, Department of Home Affairs, STATSSA.
33	Increased risk of wildfires	Increased risk of wildfires linked to higher ambient temperatures, dry spells and more frequent	Is this or will this take place in your area?	Yes	Due to drought and heat waves, Higher risk, All three local municipalities	What is the Veld Fire Risk Status of the area? Extreme or High = High; Medium; Low	High	Loss of crop and livestock and susceptible to fires from veldfires from MP and the Free State. Also loss of shelter.	Medium	KZN Wildlife. Cross-border mutual assistance. PDMC. Roads incidence management systems. District DDMC.

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
		lightning storms.								
34	Decreased income from tourism	Reduced income from tourism as a result of reduced recreational opportunities and increased impact on tourism-supporting infrastructure, such as conservation area access roads.	Do you have tourism assets that can be impacted by climate change in your area?	Yes	Chelmsford, Balele, Ncandu River	How significant is tourism to the local economy? Significant contributor = High; Some contribution = Medium; Low/No contribution = Low	Low	Loss of income for those currently employed in tourism sector and loss in terms of contribution for ADM economy, especially in the hospitality sector.		Tourism Plan, KZN Wildlife, Birdlife SA, CTO Reports

5.5 Water

Table 8: Water Vulnerability Indicator Table Amajuba District Municipality

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
35	Decreased quality of drinking water	Deterioration in water quality due to increased salt concentrations in dams, wetlands and soil/plant systems from enhanced evaporation rates.	Is this or will this take place in your area?	Yes	Deterioration in water quality in all three local municipalities, Ntshingwayo Dam	What is the Blue Drop Score for the area (2012 Report)? Less than 50% = high; Between 50% & 90% = Medium; More than 90% = low	Medium	Blue drop score is 58%.		DWS ADM- Water services Authority NN- Water services Authority
36	Decreased water quality in ecosystem due to floods and droughts	More frequent floods result in increased effluent overflow into rivers. Increased drought mean less water is available to dilute wastewater discharges and irrigation return flows to rivers.	Is this or will this take place in your area?	Yes	2015/16 drought, All three local Municipalities were affected.	What is the Green Drop Score for the area? Less than 50% = high; Between 50% & 90% = Medium; More than 90% = low	Medium	Greendrop score is 60.36%.		DWS, ADM WSDP. NN Water services Authority. Infrastructure needs to be upgraded. Constant sewage overflows. Poor stormwater management systems.
37	Less water available for	Increased periods of drought mean less water is available.	Is this or will this take place	Yes	2015/16 drought,	Years of drought over the past 20	Medium	2015/16 drought		DWS, Farmers

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
	irrigation and drinking		in your area?		In all three local municipalities	years More than 7 incidence = High; Between 7 & 2 incidence = Medium; Less than 2 incidence = Low;				Association, KZNDARD
38	Increased impacts of flooding from litter blocking storm water and sewer systems	Human health and ecosystem impacts, associated with increased rainfall intensities, flash floods and regional flooding resulting in litter and washed-off debris blocking water and sanitation systems.	Is this or will this take place in your area?	Yes	All three local municipalities, Storms, Ageing water infrastructure	Percentage of Households using no rubbish disposal More than 10% = High; Between 10% & 5% = Medium; Less than 5% = Low				LM's Infrastructure Plan, DWS. Poor stormwater management systems.
39	Increased fish mortality	Increased freshwater fish mortality due to reduced oxygen concentrations in aquatic environments and mortality of temperature-sensitive fish species.	Do you have fresh water fish in your area?	Yes	Ntshingwayo, Ncandu, Buffalo	How significant is fresh water fish to livelihoods? Significant to livelihoods = High; Some dependence =				KZN Ezemvelo, WWF

No	Name Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
						Medium; Low/No dependence = Low				

5.6 Vulnerability Assessment Summary

The tables below list the high and medium priority climate change indicators for the municipality.

5.6.1 High Priority Climate Change Indicators

Based on the above vulnerability assessment the following indicators were identified as high priority climate change vulnerabilities for the municipality. These were shortlisted by answering “yes” to exposure, “high” to sensitivity and “low” to adaptive capacity.

Table 9: High Priority Indicators Amajuba District Municipality

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
7	Agriculture	Change in other crop production areas (e.g. vegetables, nuts, etc.)	Yes	High	Low
10	Agriculture	Increased risks to livestock	Yes	High	Low
11	Agriculture	Reduced food security	Yes	High	Low

5.6.2 Medium Priority Climate Change Indicators

Based on the above vulnerability assessment the following indicators were identified as medium priority climate change vulnerabilities for the municipality. These were shortlisted by answering “yes” to exposure, “medium” or “high” to sensitivity and “low” or “medium” to adaptive capacity.

Table 10: Medium Priority Indicators Amajuba District Municipality

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
1	Agriculture	Change in grain (maize, wheat & barley) production	Yes	High	Medium
8	Agriculture	Increased areas for commercial plantations	Yes	Medium	Low
9	Agriculture	Increased exposure to pests such as eldana, chilo and codling moth	Yes	High	Medium
12	Biodiversity and Environment	Loss of High Priority Biomes	Yes	High	Medium
13	Biodiversity and Environment	Increased impacts on threatened ecosystems	Yes	High	Medium
14	Biodiversity and Environment	Increased impacts on environment due to land-use change	Yes	High	Medium

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
15	Biodiversity and Environment	Loss of Priority Wetlands and River ecosystems	Yes	High	Medium
21	Human Health	Health impacts from increased storm events	Yes	Low	Medium
22	Human Health	Increased heat stress	Yes	High	High
24	Human Health	Increased water borne and communicable diseases (e.g. typhoid fever, cholera and hepatitis)	Yes	High	Medium
25	Human Health	Increased malnutrition and hunger as a result of food insecurity	Yes	Medium	High
26	Human Health	Increased air pollution	Yes	High	Medium
27	Human Health	Increased Occupational health problems	Yes	Medium	High
28	Human Settlements, Infrastructure and Disaster Management	Loss of industrial and labour productivity	Yes	High	Medium
29	Human Settlements, Infrastructure and Disaster Management	Increased impacts on strategic infrastructure	Yes	High	Medium
30	Human Settlements, Infrastructure and Disaster Management	Increased impacts on traditional and informal dwellings	Yes	High	Medium
31	Human Settlements, Infrastructure and Disaster Management	Increased isolation of rural communities	Yes	Medium	Medium
32	Human Settlements, Infrastructure and Disaster Management	Increased migration to urban and peri-urban areas	Yes	Medium	Low
33	Human Settlements, Infrastructure and Disaster Management	Increased risk of wildfires	Yes	High	Medium

6 References

- Amajuba District Municipality. 2006. "Amajuba Agricultural Plan."
- . 2013. "Amajuba District Municipality Spatial Development Framework (SDF) 2013/2014: Final Composite Report."
- . 2016a. "Amajuba District Municipality Final Integrated Development Plan 2016/2017."
- . 2016b. "Amajuba District Municipality Spatial Development Framework (SDF) 2016/2017: Final Composite Report."
- . 2017. "Draft Integrated Development Plan: 2017/18-2021/22 (5 Year Development Plan)."
- Amos, E, Akpan, U, and Ogunjobi, K. 2015. "'Households' Perception and Livelihood Vulnerability to Climate Change in a Coastal Area of Akwa Ibom State, Nigeria" 17 (4):887–908.
- Böckmann, M. 2015. "Exploring the Health Context: A Multimethod Approach to Climate Change Adaptation Evaluation." Bremen: Universität Bremen. <https://elib.suub.uni-bremen.de/edocs/00104711-1.pdf>.
- Climate System Analysis Group. 2017a. "Future Climate Projections." http://cip.csag.uct.ac.za/webclient2/datasets/africa-merged-cmip5/#nodes/cmip5-anomalies?folder_id=33&extent=99843.
- . 2017b. "Historical Climate Monthly Averages." http://cip.csag.uct.ac.za/webclient2/datasets/africa-merged-cmip5/#nodes/seasonality-cmip5?folder_id=33&extent=99843.
- Council for Scientific and Industrial Research. 2011. "National Freshwater Ecosystem Priority Areas (NFEPA): Wetlands 2011 [Vector Geospatial Dataset]." <http://bgis.sanbi.org/SpatialDataset/Detail/395>.
- Davis, C.L. 2011. "Climate Risk and Vulnerability: A Handbook for Southern Africa." <http://start.org/download/2011/sadc-handbook-11.pdf>.
- De Lange, B. 2013. "Eskom Internal Report RES/RR/12/35052: Commercial Forests in South Africa." Eskom. http://bea.dirisa.org/resources/metadata-sheets/WP06_01_META_Commercial.pdf.
- Department of Agriculture, Forestry and Fisheries. 2010. "Map Showing the Risk of Veld Fires in South Africa."
- Department of Cooperative Government and Traditional Affairs. nd. "Amajuba District Growth and Development Plan 'Vision 2030.'"
- Department of Environmental Affairs. 2009. "National Protected Area Expansion Strategy Resource Document." https://www.environment.gov.za/sites/default/files/docs/npaes_resource_document.pdf.
- . 2013a. "Climate Trends and Scenarios for South Africa; LTAS Phase 1, Technical Report (No. 1 of 6)." <https://drive.google.com/open?id=0B88z-WjOEKlZy0xcG1KTGthSlk>.
- . 2013b. "Long Term Adaptation Scenarios: Climate Change and Biodiversity, Climate and Impacts Factsheet Series, Factsheet 7 of 7." <http://www.sanbi.org/sites/default/files/documents/documents/ltas-factsheetclimate-change-and-biodiversity-sector2013.pdf>.
- . 2013c. "Long Term Adaptation Scenarios: Climate Change and the Agriculture Sector, Climate and Impacts Factsheet Series, Factsheet 4 of 7." <http://www.sanbi.org/sites/default/files/documents/documents/ltas-factsheetclimate-change-and-agriculture-sector2013.pdf>.
- . 2013d. "Long Term Adaptation Scenarios, Phase 1 - Technical Report - No 1 of 6 - Climate Trends and Scenarios for South Africa." <https://drive.google.com/file/d/0B88z-WjOEKlZy0xcG1KTGthSlk/>.
- . 2013e. "Long-Term Adaptation Scenarios Flagship Research Programme for South Africa. Climate Trends and Scenarios." Department of Environmental Affairs. <https://www.sanbi.org/sites/default/files/documents/documents/ltasclimate-trends-and-scenarios-tech-report2013low-res.pdf>.

- . 2015. "Climate Change Adaption: Perspectives on Urban, Rural and Coastal Human Settlements in South Africa." Technical Report. Pretoria.
- . 2017. "South Africa Protected Areas Database (SAPAD_OR_2017_Q2) [Vector Geospatial Dataset]." <http://egis.environment.gov.za>.
- Department of Water Affairs. 2011. "2011 Blue Drop Report." <https://www.dwa.gov.za/Documents/BD/BDIntro.pdf>.
- . 2013. "National Water Resources Strategy: Second Edition." https://www.dwaf.gov.za/nwrs/LinkClick.aspx?fileticket=u_qFQycClbI%3d&tabid=91&mid=496.
- Department of Water and Sanitation. 2013. "2013 Green Drop Report - Volume 1: Municipal and Private Wastewater Systems." http://www.dwa.gov.za/Dir_WS/GDS/Docs/UserControls/DownloadSiteFiles.aspx?id=74.
- . 2014. "2014 Blue Drop Report." https://www.dwa.gov.za/dir_ws/DWQR/subscr/ViewComDoc.asp?Docid=703.
- . 2016a. "Green Drop System." 2016. https://www.dwa.gov.za/dir_ws/GDS/DefaultTopPerformers.aspx?ProvCode=SA.
- . 2016b. "Dam Hydrological Data." <https://www.dwaf.gov.za/iwqs/wms/data/000key.asp>.
- Driver, A., Sink, K.J., Nel, J.N., Holness, S., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L., and Maze, K. 2012. *National Biodiversity Assessment 2011: An Assessment of South Africa's Biodiversity and Ecosystems: Synthesis Report*. Pretoria: South African National Biodiversity Institute and Department of Environmental Affairs.
- Health Systems Trust. 2012. "National-Health-Facilities-Audit.pdf." <https://www.health-e.org.za/wp-content/uploads/2013/09/National-Health-Facilities-Audit.pdf>.
- Jiri, O. 2016. "Climate Change and Variability Impacts on Crop Production in the Low Potential Smallholder Farming Regions of Zimbabwe." PhD thesis, Pietermaritzburg: University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/bitstream/handle/10413/13962/Jiri_Obert_2016.pdf?sequence=1&isAllowed=y.
- Koske, J, and Ochieng, M.A. 2013. "The Level of Climate Change Awareness and Perception among Primary School Teachers in Kisumu Municipality, Kenya" 3 (21):174–79.
- Kruger, A.C, and Shongwe, S. 2004. "Temperature Trends in South Africa: 1960–2003" 15 (24):1929–45.
- KwaZulu-Natal Provincial Treasury. 2014. "Socio-Economic Profile Amajuba District Municipality Profile." 2014. http://www.kzntreasury.gov.za/ResourceCenter/Documents%20%20Fiscal%20Resource%20Management/Socio-Economic%20Profile_Amajuba_District_Municipality_Profile_FINA_24_NOV_2014.pdf.
- Linkd Environmental services. 2013. "Draft Document: Climate Change Risk and Vulnerability Assessment for Rural Human Settlements." [:http://www.ruraldevelopment.gov.za/phocadownload/draftvulnerabilityassessment1204131psc.pdf](http://www.ruraldevelopment.gov.za/phocadownload/draftvulnerabilityassessment1204131psc.pdf).
- Massyn, N, N Peer, R English, A Padarath, P Barron, and C Day, eds. 2016. "District Health Barometer 2015/16." Health Systems Trust.
- Meyiwa, T, Maseti, T, Ngubane, S, Letsekha, T, and Rozani, C. 2014. "Women in Selected Rural Municipalities: Resilience and Agency against Vulnerabilities to Climate Change" 3 (28):102–14.
- Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: A Framework for Assessment*. Washington DC: Island Press.
- Montmasson-Clair, G, and Zwane, M. 2016. "Climate Change Adaptation and Agriculture in South Africa: A Policy Assessment." http://awsassets.wwf.org.za/downloads/wwf_pfu_policy_brief_lowres_.pdf.

- Mucina, L., and M.C. Rutherford, eds. 2006. *The Vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. Pretoria: South African National Biodiversity Institute. <https://www.sanbi.org/documents/vegetation-south-africa-lesotho-and-swaziland-strelitzia-19>.
- Nelitz, M, Boardley, S, and Smith, R. 2013. "Tools for Climate Change Vulnerability Assessments for Watersheds." <http://www.mirocan.org/public/documents/outils/uploaded/nxdzgA3x.pdf>.
- Nicholson-Cole, S.A. 2005. "Representing Climate Change Futures: A Critique on the Use of Images for Visual Communication" 3 (29):255–273.
- Parikh, J. 2007. "Gender and Climate Change Framework for Analysis, Policy & Action." https://archive.nyu.edu/bitstream/2451/34216/2/gnder_cc.pdf.
- Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson. 2007. "Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change." Cambridge University Press. https://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html.
- SANBI. 2011. "Freshwater Ecosystem Priority Areas (FEPAs) for River Ecosystems [Vector Geospatial Dataset]." South African National Biodiversity Institute.
- Schulze, R.E, and N.J Walker. 2007a. "Maize Yield Estimation." In *South African Atlas of Climatology and Agrohydrology*. Vol. 1489/1/06. Water Research Commission. http://bea.dirisa.org/resources/metadata-sheets/WP03_00_META_MAM.pdf.
- . 2007b. "Sorghum Yield Estimation." In *South African Atlas of Climatology and Agrohydrology*. Vol. 1489/1/06. Water Research Commission. http://bea.dirisa.org/resources/metadata-sheets/WP03_00_META_SRG.pdf.
- . 2007c. "Soybean Yield Estimation." In *South African Atlas of Climatology and Agrohydrology*. Vol. 1489/1/06. Water Research Commission. http://bea.dirisa.org/resources/metadata-sheets/WP03_00_META_SOB.pdf.
- . 2007d. "Sugarcane Yield Estimation." In *South African Atlas of Climatology and Agrohydrology*. Vol. 1489/1/06. Water Research Commission. http://bea.dirisa.org/resources/metadata-sheets/WP03_00_MEATA_SUC.pdf.
- Shezi, N, and Ngcoya, M. 2016. "Adaptation to the Impacts of Climate Change on Agriculture in eThekweni: A Literature Review." http://appliedpovertyreduction.ukzn.ac.za/wp-content/uploads/2016/09/climate-change-and-agriculture_final_print.pdf.
- Singh, V, and E Kistnasamy. 2014. "Potential Climate Change Impacts on Environmental Health Services: Perspectives from a Developing Country" 2 (3):113–18. <https://doi.org/DOI:10.12691/ajphr-2-3-9>.
- South African National Biodiversity Institute. 2011. "National List of Threatened Ecosystems 2011 [Vector Geospatial Dataset]." <http://bgis.sanbi.org/SpatialDataset/Detail/501>.
- South African National Parks. 2011a. "CCAB - Current Biome Delineations 2011 [Vector Geospatial Dataset]." Available from the Biodiversity GIS website. <http://bgis.sanbi.org/SpatialDataset/Detail/484>.
- . 2011b. "CCAB - High Risk Scenarios - Biome Delineations 2011 [Vector Geospatial Dataset]." Available from the Biodiversity GIS website. <http://bgis.sanbi.org/SpatialDataset/Detail/486>.
- . 2011c. "CCAB - Medium Risk - Climate Scenarios - Biome Delineations 2011 [Vector Geospatial Dataset]." Available from the Biodiversity GIS website. <http://bgis.sanbi.org/SpatialDataset/Detail/475>.
- South African National Parks / South African National Biodiversity Institute. 2011. "National Biodiversity Assessment 2011: Protect Areas [Vector Geospatial Dataset]."
- Statistics South Africa. 2011. "Census 2011 Statistical Release." Pretoria.
- . 2015. "Mortality and Causes of Death in South Africa, 2015: Findings from Death Notification."
- stepSA. 2016. "Spatial Indicators: Social-Economic Indicators." stepSA - Spatial and Temporal Evidence for Planning in South Africa. 2016. http://stepsa.org/socio_econ.html#Indicator.

- United Nations WomenWatch. 2009. "Women, Gender Equality and Climate Change."
http://www.un.org/womenwatch/feature/climate_change/.
- Warburton, M.L. 2012. "Challenges in Modelling Hydrological Responses to Impacts and Interactions of Land Use and Climate Change." PhD thesis, Pietermaritzburg: University of KwaZulu-Natal.
http://researchspace.ukzn.ac.za/xmlui/bitstream/handle/10413/9436/Warburton_Michele_Lynn_2012.pdf?sequence=1.
- Warburton, M.L, and Schulze, R. 2006. "Climate Change and the South African Commercial Forestry Sector. An Initial Study."
http://www.forestry.co.za/uploads/File/industry_info/environment/Climate%20change%20on%20forestry.pdf.
- World Health Organization. 2017. "Climate Change and Health."
<http://www.who.int/mediacentre/factsheets/fs266/en/>.
- Ziervogel, G, and Calder, R. 2003. "Climate Variability and Rural Livelihoods: Assessing the Impact of Seasonal Climate Forecasts in Lesotho" 4 (35):403-17.