ENVIRONMENTAL PLANNING & CLIMATE PROTECTION DEPARTMENT

ETHEKWINI MUNICIPALITY

ENERGY OFFICE

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Title: Durban Climate Change Strategy

Final Draft for Council Approval

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Approved by: Mr Derek Morgan and Dr Sean O'Donoghue

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The content of this draft strategy is based on stakeholder input that was received at public meetings and through written submissions, and the input of technical experts throughout the course of the project.

Executive Summary

Human-induced climate change has been identified globally as one of the key challenges of our age. Cities such as Durban need to respond by adapting to the impacts of a changing climate while reducing their contributions to climate change. To address this challenge, the eThekwini Municipality has developed the Durban Climate Change Strategy (DCCS) as part of the Municipal Climate Protection Programme, with the aim of defining a city-wide approach to adapting to climate change and mitigating Durban's contribution to climate change.

Durban, like other cities across the world, contributes to the emission of greenhouse gases (GHG) globally. The most recent GHG inventory compiled for Durban was for the 2012 calendar year, in which the total amount of greenhouse gas emissions recorded for the entire city was 29,360,395 tonnes of carbon dioxide equivalent (tCO_2e)[1]

Transportation and industry are the largest contributors to Durban's GHG emissions, with transportation making up 37% of the total GHGs, and industry emissions contributing 32%. Other significant contributors to Durban's GHG emissions are the residential sector, the commercial sector and the eThekwini Municipal Administration.

In addition to contributing to global GHG emissions, Durban will also continue to experience the impacts of climate change. The following changes in climate are projected for Durban:

- The average annual temperature increase is expected to be between 1.5°C and 2.5°C by 2065, and increase between 3^0C and 5^0C by 2100.
- Potential increase in aggregated rainfall by 2065 with an increase of up to 500 mm by 2100.
- The northern parts of the Municipality are expected to experience increases of up to 20% in long duration (1 day and longer) rainfall.
- The outer west areas are predicted to experience increases in short duration rainfall which may lead to localised increases of up to 30% in short term flooding.
- An estimated 30% to 100% increase in year-to-year rainfall variability.
- More intense rainfall events with increased erosive capacity.
- Increasing numbers of heat waves.
- Future sea level rise is expected to be greater than the current rate of 2.7 (+/- 0.05) mm/year.

As a result of these changes, there are a number of risks that Durban may face in the future. These include changes from year to year in water availability, potential damage to infrastructure, threats to biodiversity and ecosystems, impacts on agriculture and food security, higher energy consumption, and health impacts. The urban poor are likely to be the

[1] Refer to Glossary for full explanation of tonnes of carbon dioxide equivalent

most at risk. These impacts are likely to be compounded by indirect or non-climate change-related risks, such as population growth rate.

Ten interrelated climate change response themes were identified through the strategy development process: Water; Sea level rise; Biodiversity; Food security; Health; Energy; Waste and pollution; Transport; Economic development; and Knowledge generation and understanding. A set of goals, objectives and responses was developed for each theme. The goals of each theme are summarised in the table below.

Theme	**Goal**
Water	Durban's water resources and infrastructure are effectively managed to ensure optimal protection from climate change impacts.
Sea level rise	Durban's protective coastal ecological infrastructure is maintained and restored where possible to provide a buffer against sea level rise and coastal storms. Durban's coastal built environment is protected where appropriate, and further development is discouraged in high risk areas.
Biodiversity	Durban's biodiversity and associated natural capital is protected and enhanced to deliver ecosystem services that provide long-term mitigation opportunities and protection from the impacts of climate change.
Food security	Durban has a robust and resilient food security system that ensures availability, equitable access to and efficient utilisation of food in the context of both climate variability and climate change**.**
Health	Durban promotes public health and safety and the prevention of diseases in the face of a changing climate. Durban's public health system is resource efficient and climate smart.
Energy	Durban has a thriving sustainable energy sector. Where appropriate, renewable energy supplies a significant proportion of Durban's energy needs, and energy is used efficiently by all sectors. All sectors have access to safe and affordable energy sources.
Waste and pollution	Durban has effective air, water, solid waste and waste water management systems in which resources are focused on reduction, re-use and recycling strategies that effectively reduce greenhouse gas emissions in all economic sectors, divert waste from landfill, and create employment opportunities. Waste infrastructure is also designed appropriately to adapt to the impacts of climate change."
Transport	Durban provides integrated, climate smart, low carbon transport systems for passengers and freight.
Economic development	Durban transitions to a low-carbon economy that is socially responsible and environmentally sustainable, provides diverse economic opportunities, and increases the capacity to adapt to the impacts of climate change.
Knowledge generation and understanding	Durban has an engaged climate change research sector that generates regionally and locally relevant knowledge that is widely disseminated to all sectors in Durban for informed decision making and action.

The implementation of the strategy will be led by the Environmental Planning and Climate Protection Department (EPCPD) and the Energy Office (EO) of eThekwini Municipality through the development of a separate Implementation Framework. This Implementation Framework will give effect to the ideals set out in this strategy and will provide a practical

bridge to a Monitoring and Evaluation System. The broad approach to implementation will entail the EPCPD and EO being responsible for mainstreaming the climate change strategy by promoting the introduction of climate change content into the Integrated Development Plan and Long Term Development Plan of the Municipality, as well as the relevant sectoral plans and policies of other municipal departments. Since successful implementation requires cross-sectoral action, all sectors are encouraged to develop plans to implement the sections of the strategy that are relevant to their sectors.

As with the National Climate Change Response White Paper, a number of near-term Durban Flagship Programmes will be implemented to ensure that both mitigation and adaptation interventions take place as soon as possible. The six Durban Flagship Programmes are as follows:

1. The Water Conservation and Demand Management Flagship Programme
2. The Renewable Energy Flagship Programme
3. The Energy Efficiency and Energy Demand Management Flagship Programme
4. The Transport Flagship Programme
5. The Waste Management Flagship Programme
6. The Adaptation Flagship Programme

Acronyms

AFSUN:	African Food Security Network
CBO:	Community-based Organisation
COP:	Conference of the Parties of the UNFCCC
CMP:	COP serving as the meeting of the Parties of the Kyoto Protocol
DAC:	Durban Adaptation Charter
DEA:	National Department of Environmental Affairs
DCCS:	Durban Climate Change Strategy
EDIPU:	EThekwini Economic Development and Investment Promotion Unit
EPCPD:	EThekwini Environmental Planning and Climate Protection Department
EO:	EThekwini Energy Office
GDP:	Gross Domestic Product
GHG:	Greenhouse Gas
HVAC:	Heating Ventilation and Cooling
IDP:	Integrated Development Plan
IRPTN:	Integrated Rapid Public Transport Network
IPCC:	Intergovernmental Panel on Climate Change
LPG:	Liquefied Petroleum Gas
LTAS:	Long Term Adaptation Scenarios
LTMS:	Long Term Mitigation Scenarios
MAPs:	Municipal Adaptation Plans
NDP	National Development Plan
M&E:	Monitoring and Evaluation
NCCRP:	National Climate Change Response White Paper
NGO:	Non-governmental Organisation
NO_x:	Oxides of Nitrogen
PV:	Photovoltaic

RPS:	Renewable Portfolio Standard
SACN:	South African Cities Network
SALGA:	South African Local Government Association
SIP:	Strategic Infrastructure Project of the South African National Government
SMS:	Short Message Service
SOE:	State-owned Enterprise
SWH:	Solar Water Heater
tCO_2e:	Tonnes of carbon dioxide equivalent greenhouses gases
UNFCCC:	United Nations Framework Convention on Climate Change
VOCs:	Volatile Organic Compounds

Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects. (IPCC AR5)

Ecological infrastructure: Naturally functioning ecosystems that deliver valuable services to people, such as climate regulation, water provision, improved water quality, flood management and fertile soils. It is the nature-based equivalent of built infrastructure and is as important in supplying basic services, socio-economic opportunities, and in underwriting human well-being.

Ecosystem services: Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

Tonnes of carbon dioxide equivalent (tCO_2e): A measure for describing how much global warming a given type and amount of greenhouse gas may cause, using an equivalent amount of carbon dioxide (CO_2) as the reference (i.e. CO_2e). For example, methane is a greenhouse gas that has a stronger effect on climate change than CO_2. To be able to compare it with the effect of CO_2, it is converted into CO_2e. In this way it is possible to say that 1 tonne of methane has the same effect on climate change as 25 tonnes of CO_2, or 1t methane = $25tCO_2e$.

Integrated Development Plan (IDP): In terms of South Africa's Municipal Systems Act, an IDP is defined as a strategic planning instrument that guides and informs all municipal planning and development in the City. It is a five year plan that consists of a long-term vision, and details the development priorities and objectives that contribute toward achieving this vision. These are implemented through allocation of budget, a process that must be linked with the IDP.

Gini coefficient: A measure of inequality of a distribution of income among individuals within a country. The higher the number is, the higher the inequality in that country is. A value of 0 represents a perfectly equal society, whereas a value of 1 indicates a highly unequal society.

Green economy: An economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities**.** In its simplest expression, a green economy can be thought of as one which is low carbon**,** resource efficient and socially inclusive (UNEP Green Economy Initiative)

Contents

Chapter 1: Introduction

Human-induced climate change has been identified globally as one of the key challenges of the 21st Century. Historical records show that the earth's climate has varied naturally over time; however, human-induced climate change refers specifically to global warming that is occurring as a result of emissions of greenhouse gases (GHGs) from a wide range of human activities. The latest research by the Intergovernmental Panel on Climate Change (IPCC) shows that global GHG emissions are continuing to grow and that human-induced emissions from 2000 to 2010 were higher than previous decades (IPCC, 2014a). The level of certainty in the link between human activities and climate has also increased from very likely (90%) in the IPCC's Fourth Assessment Report published in 2007, to extremely likely (95%) in the recently released Fifth Assessment Report (IPCC, 2013). According to the latest IPCC Assessment Report, "*it is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcing together"*(IPCC, 2013:17). The IPCC has found that in recent decades human-induced climate change has "*caused impacts on natural and human systems on all continents and across the oceans*" (IPCC, 2014b:6).

The impact of climate change is likely to fall disproportionately on cities of the global south, such as Durban, which are already facing developmental and other challenges. It is widely acknowledged that despite Africa's minimal contribution to global greenhouse gas emissions, the continent is predicted to experience severe consequences from climate change, such as amplified water-stress and food insecurity. Climate change is likely to undermine development efforts in the region and exacerbate poverty. Africa is particularly vulnerable because it lacks the capacity to cope with climate change impacts due to its socio-economic status, political constraints and limited access to technology (IPCC, 2014c).

To address the challenge of climate change, eThekwini Municipality - the local government entity responsible for planning and managing Durban - has developed the Durban Climate Change Strategy (DCCS) as part of its Municipal Climate Protection Programme. The DCCS lays out a city-wide approach to adapting to climate change and mitigating Durban's contribution to climate change. Climate change adaptation refers to: *"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects."* (IPCC, 2013:3). Whereas climate change mitigation refers to: "*A human intervention to reduce the sources or enhance the sinks of greenhouse gases*." (IPCC, 2013:1458).

The development of the DCCS was initiated by the Environmental Planning and Climate Protection Department (EPCPD) and the Energy Office (EO) of eThekwini Municipality as a first step in aligning and ensuring synergy between the adaptation and mitigation work being undertaken in the city. Since climate change is expected to affect all sectors of society in Durban, the response outlined in this strategy represents a Durban-wide response, which seeks to create an enabling environment for partnerships across different sectors and

stakeholders. In order to realise this approach, the strategy content was developed through a participatory process that included the following key steps:

- **Initial phase of consultation:** In this phase, stakeholders were invited to provide input on which climate change issues should be addressed by the DCCS. This was done through internet-based and short message service (SMS) initiated telephonic stakeholder surveys, face-to-face meetings and telephone interviews. Based on this input, and during a public meeting, the vision and seven topic themes and two cross-cutting themes were identified for the strategy. These topic themes included: Water; Biodiversity; Food security; Health; Waste and pollution; Energy; and Transport. The two cross-cutting themes - Economic development and Knowledge generation and understanding - emerged as key topics for consideration across all seven themes.

- **Theme reports:** In this phase, technical experts were appointed for the seven topic themes to provide an expert overview of climate change issues within their respective themes for participants attending a series of theme workshops. The participants at the theme workshops then provided detailed input on the climate change responses that they proposed for each respective theme. Based on this input and the views of the appointed technical experts, theme reports were developed for the seven topic themes. The theme reports were made available for public comment. These theme reports also went through a second round of review by relevant eThekwini Municipality officials. As Economic development and Knowledge generation and understanding were listed as cross-cutting themes, no experts were appointed or theme reports compiled for these themes. During this process of review, the need to establish separate theme reports for Sea level rise and for the two cross-cutting themes was identified.

- **Consolidated strategy:** The theme reports were then consolidated into a draft strategy document that was made available for a final phase of public comment. Once all the comments had been reviewed, the draft strategy was revised. This strategy document will now be submitted to eThekwini Municipality Council for consideration and approval.

This is the first iteration of the Durban Climate Change Strategy and it is expected that this document will be revised and updated regularly. Future iterations will be informed by the outcomes of implementation efforts, increasing knowledge of the implications of climate change for Durban, and the continued exploration and development of locally appropriate adaptation and mitigation responses

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Figure 1: *Word Cloud* developed from the Durban Climate Change Strategy document with the words "eThekwini", "Municipality", "Durban", "climate" and "change" removed

Chapter 2: Introduction to Durban

Durban is a port city that is situated on the east coast of South Africa. Managed by the eThekwini Municipality, the city is home to a population of approximately 3.4 million people (eThekwini Municipality, 2014a). Between 2001 and 2011 the population of Durban grew at an average annual percentage of 1.13% (eThekwini Municipality, 2014a). Migration is a significant contributing factor to population growth in Durban, with most migrants to the city being drawn from the province of KwaZulu-Natal (eThekwini Municipality, 2014a). This inward movement of people to the city could in future be exacerbated by negative climate change impacts on rural livelihoods that will further promote rural to urban population migration.

The eThekwini Municipality governs an area of 2,297km^2 that includes urban and rural communities (eThekwini Municipality, 2012a). Two thirds of the municipal area is rural or semi-rural, and 9% of the population resides in rural areas (eThekwini Municipality, 2011a). While 68% of Durban's population lives in formal areas (eThekwini Municipality, 2011a), increased migration from rural to urban areas has resulted in sprawling informal settlements where 23% of Durban's population resides (eThekwini Municipality, 2011a).

The main languages of Durban are isiZulu and English, with 62% of Durban's population speaking isiZulu and 26% speaking English (Statistics South Africa, undated). In 2012, 289,251 people in the municipal area were regarded as illiterate; this is equivalent to approximately 8% of the population (eThekwini Municipality, 2014a).

The table below shows some of the basic service delivery statistics cited in the eThekwini Municipality's Integrated Development Plan[2]. All of the figures cited are baseline figures as of the 30 June 2013 and are used to track progress by the city going forward.

Table 1: EThekwini Municipality Basic Service Delivery Statistics, adapted from eThekwini Municipality IDP (eThekwini Municipality, 2014a)

Area	Indicator	Figure as at 30 June 2013
Electricity	The percentage of households with access to a basic level of electricity	69.30%
Solid Waste Disposal	The percentage of households with access to a basic level of solid waste disposal	100.00%
Water and Sanitation	The percentage of households with access to a basic level of water provision	92.44%
	The percentage of households with access to a basic level of sanitation	76.92%

[2] Table adapted from the Reviewed Scorecard Table in the eThekwini Municipality's Integrated Development Plan (eThekwini Municipality, 2014a:172-173)

EThekwini Municipality's Integrated Development Plan (eThekwini Municipality, 2014a) indicates that eThekwini's Gross Domestic Product (GDP) (in constant 2005 prices) amounted to R210 billion in 2012 and comprised 10.7% of the National GDP. Key sectors of the municipal economy include (eThekwini Municipality, 2014):

1. Finance - accounting for 22% of the GDP
2. Manufacturing – accounting for 22% of the GDP
3. Community services – accounting for 18% of the GDP
4. Trade – accounting for 16% of the GDP
5. Transport – account for 16% of the GDP; and
6. Construction – accounting for 3% of the GDP

EThekwini Municipality's Integrated Development Plan (eThekwini Municipality, 2014) notes that in 2010 the percentage of people living in poverty was 32.3%. The strict unemployment[3] rate in Durban was 20.6% in 2012 (Global Insight Data, 2014a). KwaZulu-Natal's expanded unemployment rate currently stands at 36.2% (Statistics South Africa, 2014). EThekwini Municipality's Economic Development and Investment Promotion Unit (EDIPU) therefore estimates that the expanded unemployment rate[4] for Durban is above 30% (Forrest, *pers. comm.*, 2014).The gap between the rich and the poor is high, with the 2011 Gini coefficient for eThekwini Municipality standing at 0.61 (Global Insight Data, 2014b). According to the UN-Habitat database, South African cities are the most unequal in the world (UN-Habitat, 2012). All of the major South African metropolitan municipalities have a Gini coefficient of over 0.6 for the 2013 year (City of Cape Town, 0.6; Ekurhuleni, 0.64; City of Johannesburg 0.64; Nelson Mandela Bay Municipality, 0.61) (Global Insight Data, 2014b).

[3] Strict unemployment rate only includes unemployed people actively looking for work.
[4] Expanded unemployment rate includes unemployed people not actively looking for work.

Chapter 3: Durban's greenhouse gas emissions

Durban, like other cities across the world, contributes to the emission of greenhouse gases (GHG) globally. The most recent GHG inventory compiled for Durban was for the 2012 calendar year. The total amount of greenhouse gas emissions recorded for the entire city was 29,360,395 tCO_2e (eThekwini Municipality, 2014b). Total emissions are estimated to have increased steadily from 19,937,000 tCO_2e in 2002 (a 47% increase over 10 years), but this may be attributed to a significant improvement in data collection (eThekwini Municipality, 2014b).

Durban's GHG Inventory is divided into two sub-inventories, one for the local government emissions, and the other for the emissions from the broader community (eThekwini Municipality, 2014b). International GHG reporting standards require inventories to be categorised as follows:

- **Scope 1**- emissions are direct emissions that result from the combustion of raw materials such as coal to generate energy and combustion of diesel or petrol for transport;
- **Scope 2**- emissions are indirect emissions that result from the production of purchased electricity and steam; and
- **Scope 3**- emissions are all other indirect emissions.

Scope 1, 2 and 3 emissions have been included in the inventory for both local government emissions and community emissions. The emissions by scope are shown in the tables below.

Table 2: Durban's Local Government Emissions by Scope for the 2012 period (EThekwini Municipality, 2014b)

Local Government Emissions by Scope			
Emissions Scope	**GHG Sources**	**Local Government Emissions (tCO_2e)**	**Contribution to Local Government Emissions**
Scope 1	Stationary Fuel Combustion, Mobile Fuel Combustion, Waste water Treatment, Solid Waste Disposal	391,810	26%
Scope 2	Electricity Consumption, Electricity Transmission & Distribution (Technical and Non-technical losses)	1,101,398	72%
Scope 3	Employee Air Travel, Transit vehicles operated by contractor, Electricity consumption by Eskom owned streetlights	33,222	2%
	Total	**1,526,430**	**100%**

Table 3: Durban's Community Emissions by Scope for the 2012 period (EThekwini Municipality, 2014b)

Community Emissions by Scope			
Emissions Scope	**GHG Sources**	**Community Emissions (tCO_2e)**	**Contribution to Community Emissions**
Scope 1	Stationary Fuel Combustion, Mobile Fuel Combustion, Solid Waste Disposal, Enteric Fermentation, Pre-harvest Cane Burning	11,580,783	42%
Scope 2	Electricity Consumption	12,573,397	42%
Scope 3	Air Transport Systems, Marine Transport	4,679,785	17%

	Systems		
	Total	**28,833,965**	**100%**

The majority of the total GHG emissions are Scope 2 emissions, closely followed by Scope 1 emissions, as shown in Figure 1 below.

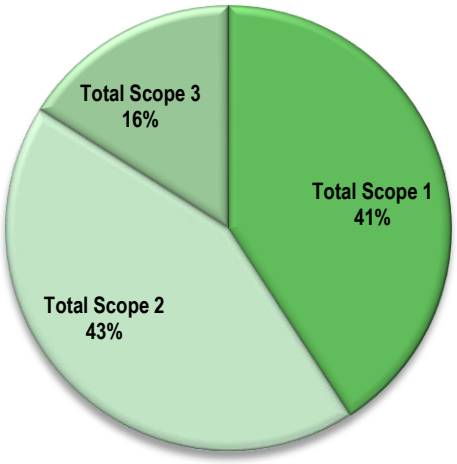

Figure 2: Total GHG emissions for Durban by scope (eThekwini Municipality, 2014b)

The 2012 GHG emissions by sector are shown in Figure 2. The figure shows that transportation and industry are the largest contributors to Durban's GHG emissions, with transportation making up 37% of the total GHGs and industry emissions 32%. Other significant contributors, through their energy consumption are the residential sector, the commercial sector and the eThekwini Municipal Administration (eThekwini Municipality, 2014b).

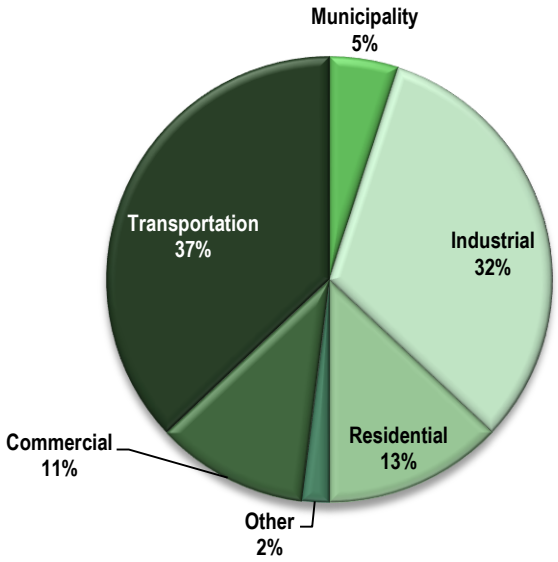

Figure 3: Total GHG emissions for Durban by sector (eThekwini Municipality, 2014b)

Chapter 4: Projected changes in Durban's climate and associated impacts

Durban is responsible for approximately 5.2% of South Africa's total GHG emissions and less than 0.1% of global GHG emissions (WRI, 2014), but will still experience impacts of global climate change. According to a report prepared by Golder Associates Africa (2010), the following changes in climate are projected for Durban:

- The average annual temperature increase is expected to be between 1.5°C and 2.5°C by 2065, and increase between 3^0C and 5^0C by 2100.
- Potential increase in aggregated rainfall by 2065 with an increase of up to 500 mm by 2100.
- The northern parts of the Municipality are expected to experience increases of up to 20% in long duration (1 day and longer) rainfall.
- The outer west areas are predicted to experience increases in short duration rainfall which may lead to localised increases of up to 30% in short term flooding.
- An estimated 30% to 100% increase in year-to-year rainfall variability.
- More intense rainfall events with increased erosive capacity.
- Increasing numbers of heat waves.
- Future sea level rise is expected to be greater than the current rate of 2.7 (+/- 0.05) mm/year[5]..

As a result of these changes, there are a number of risks that Durban may face in the future. These have been summarised as follows (Golder Associates Africa, 2010):

Changes to water availability: Durban is projected to experience increasing and more varied rainfall. The northern parts of Durban are projected to experience increases in long duration rainfall, whilst the outer west areas are projected to experience increases in short duration rainfall. Owing to these expected changes in rainfall patterns, water availability will be affected. The efficacy of dams to capture and store sufficient water will be impacted, as will the amount of water available for human consumption and industrial use. An increase in temperature may lead to increased evaporation rates thereby influencing water availability. Furthermore, extreme weather events will also have an impact on water quality and sanitation infrastructure (Golder Associates Africa, 2010).

Damage to infrastructure: Durban is projected to experience an increase in the frequency and intensity of extreme weather events, including flash floods, droughts, and an increase in the number and severity of coastal storms - which will be exacerbated by sea level rise. Coastal areas will likely experience increased erosion, which will put infrastructure and other coastal assets at risk (Mather, 2008). The resulting damage to infrastructure could impact on the provision of services such as water, electricity, storm water management, sanitation and waste management and housing provision. Industry, especially in low-lying areas, may also

[5] 2.7mm/annum is based on historical data from Durban tide gauges spanning the period 1970 to 2003.

be affected. Durban will need to invest in systems to increase the resilience of infrastructure to extreme weather events.

Threat to biodiversity and ecosystems: Durban is located in the Maputaland-Pondoland-Albany global biodiversity hotspot (Roberts, *et al*., 2012). A change in climate is expected to result in changes to ecosystem structure and functioning and loss of endemic species that are sensitive to changes in climate. An increase in invasive alien plant species associated with increased temperatures and atmospheric carbon levels is also expected. Intensification of short duration rainfall may result in increased erosion and siltation of dams and wetlands, and extreme coastal storms may result in coastal erosion and a loss of coastal vegetation. Sea level rise could result in further erosion of the coast and cause the water depth at inter-tidal zones to increase, thereby impacting on sensitive coastal habitats, especially estuaries (Golder Associates Africa, 2010). Important ecosystem services, such as the storing and filtering of water, coastal protection and the cooling of urban areas, may be compromised as a result of the projected negative impacts on the city's ecosystems.

Impact on agriculture and food security: Current climate variability in southern Africa already poses a significant challenge to food security in the region, with projected climate changes posing an even greater threat, as they stand to exacerbate this existing vulnerability (Ziervogel and Frayne, 2011).

Changes in climate are projected to have a negative influence on agriculture and food security in Durban. Possible impacts of increased temperatures in Durban include damage to crops and heat stress for livestock. Furthermore, high temperatures could result in a reduction in the amount of land that is suitable for rain fed agriculture, thereby creating a greater demand for irrigation. Higher temperatures could also have a negative effect on food quality and food safety, increasing the need for cold storage, particularly during transport. Extreme weather events are predicted to affect food supply chains by damaging transport networks, food storage facilities and processing plants. It has been projected that flooding may result in water-logged soils and leaching of nutrients impacting on crop harvests. Projected sea level rise could impact on fish nurseries through changes in salinity in estuaries, which would affect the fishing industry. Owing to the projected increase in the variability of rainfall, food production may be compromised in both commercial and subsistence farming, impacting on food security (Golder Associates Africa, 2010).

Health impacts: Durban is expected to get warmer and wetter, which could result in heat stress and higher incidences of heat-related vector-borne diseases, such as malaria, and water-borne diseases, including cholera. Residents living in damp conditions may develop respiratory illnesses. As a result of increased temperatures, food will spoil quicker and the risk of food-borne diseases will increase (Golder Associates Africa, 2010). The poor, the elderly and the sick will be worst affected, which may place a strain on available medical resources (Ebi, *et al*., 2006). Durban is predicted to experience increased extreme weather events, which may have an impact on human safety and well-being, especially in poorly planned formal and informal settlements (Golder Associates Africa, 2010). Increases in extreme events may also result in increased insurance costs in formal areas (Golder

Associates Africa, 2010). Heavy rainfall and floods are predicted to damage storm water, sewerage, and water treatment facilities, which increases the risk of water-borne infectious diseases (Golder Associates Africa, 2010).

Higher energy consumption: Durban is expected to experience higher levels of energy consumption due to increased cooling needs, placing additional stress on electricity supply (Golder Associates Africa, 2010).

Economic impacts: Projected changes in climate could be detrimental to the local economy of eThekwini Municipality. Disruptions to service provision, damage to infrastructure and the impact that climate change may have on the health of Durban's workforce are just some of the possible impacts. There are, however, some potential positive impacts that Durban may experience due to climate change. These include the development of new green economy sectors such as renewable energy, waste beneficiation and investment in ecosystem services.

Poor most at risk: Poor communities, especially those that live in informal settlements, are expected to be most affected by climate change in Durban. These communities often reside in areas at risk of flooding, often in houses that are not resistant to extreme weather conditions, and do not generally have the resources to cope with shocks from extreme events (Feiden, 2011). These problems are expected to be exacerbated by climate change. Many poor households rely on urban agriculture as a source of food (van Niekerk and van Niekerk, 2013). Greater variability in rainfall could negatively impact upon their ability to subsist off the land. A decrease in agricultural yields will generally result in higher food prices, which will affect the poor the most. The lack of social cohesion due to mistrust and lack of accountable governance in some poor communities can hinder the implementation of adaptation measures, thus placing the poor at greater risk to the impacts of climate change (Golder Associates Africa, 2011).

Chapter 5: The policy context for Durban's Climate Change Strategy

Durban hosts the secretariat of the Durban Adaptation Charter, which was developed and adopted in 2011 at the Local Government Convention convened as part of the international Local Government Roadmap[6] at the United Nations Framework Convention on Climate Change's COP17/CMP7[7] (ICLEI, 2014). The Durban Adaptation Charter has been signed by over 1,100 local government organisations globally and commits signatories to a set of ten key local government adaptation interventions (www.durbanadaptationcharter.org).

Nationally, South Africa has set a goal of achieving a 34% reduction in GHG emissions nationally against business as usual by 2020, and a 42% reduction against business as usual by 2025. This was announced by the Presidency in 2009 at COP15/CMP5 in Copenhagen, Denmark, and is subject to the provision of appropriate financial, technical and capacity building support from more developed countries (Department of Environmental Affairs, 2011). In addition to formally committing to this target, South Africa has published a National Climate Change Response White Paper (NCCRP) which documents the vision and policy of the South African government in developing an effective response to climate change and moving towards a low carbon economy. Both adaptation and mitigation responses are included in the NCCRP.

The Long Term Mitigation Scenarios (LTMS) was a research process undertaken to inform long term climate change mitigation policy in the country. The LTMS focused on understanding the rationale of South Africa reducing greenhouse gases, what options are available to achieve this, and the scope and cost of these options. The LTMS outlined various scenarios for the country's GHG emissions profile ranging from "Growth without Constraints" to "Required by Science". The LTMS also quantified a number of mitigation actions or "wedges" that would be needed to bring the emissions profile of the country to match the "Required by Science" scenario (Scenario Building Team, 2007).

The Long Term Adaptation Scenarios Flagship Research Programme (LTAS) has been established by the Department of Environmental Affairs to develop national and sub-national adaptation scenarios for South Africa. LTAS is in the process of producing a series of reports which present a consensus of climate change trends, projections and key impacts, and identifies response options for primary sectors, namely water, agriculture and forestry, human health, marine fisheries, human settlements, food security, disaster risk reduction and management, economy and biodiversity (South African National Biodiversity Institute, 2014). Climate change also features prominently in the National Development Plan (NDP),

[6] ICLEI – Local Governments for Sustainability's Local Government Roadmap aims to ensure that a strong and ambitious global climate regime is designed and implemented. http://www.iclei.org/index.php?id=1197.

[7] The United Nation Framework Convention on Climate Change (UNFCCC) 17th Conference of the Parties (COP) and 7th Conference for the meeting of the Parties for the Kyoto Protocol (CMP). These are the annual international climate change negotiations aimed at developing a legally binding agreement by all nations to address the issue of global climate change.

the roadmap developed by the National Planning Commission in 2011 that outlines the actions required to eliminate poverty and reduce inequality by 2030. Chapter five, titled *Environmental Sustainability and Resilience*, outlines a number of objectives and actions aimed at ensuring environmental sustainability and an equitable transition to a lower carbon economy. In addition, issues relevant to an effective climate change response also appear in some of the other chapters in the NDP, including Chapter 3: *Economy and Employment*, which includes a focus on the green economy, transition to a low carbon economy and society, and motivation for green product and service development; Chapter 4: *Economic Infrastructure*, which includes reference to the efficient and effective implementation of the environmental impact management governance system. Chapter 6 focuses on the promotion of an integrated and inclusive rural economy, and Chapter 8: *Transforming Human Settlements* focuses on green cities and sustainable development.

Locally, climate change is listed as one of the key development challenges facing Durban in eThekwini Municipality's Integrated Development Plan (IDP), and the impacts of climate change on development are emphasised. The IDP states that climate change adaptation needs to become a top priority for the city.

"…climate change runs the risk of undoing all of the development gains of the last one and a half decades, and for a city such as Durban climate change adaptation in all sectors will have to become one of the Municipality's top development priorities"

(EThekwini Municipality, 2014:76).

Climate change is also identified as a key issue in the eThekwini Municipality's Long Term Development Plan. The Long Term Development Plan is a multi-stakeholder plan that assigns actions for different stakeholders in Durban under six key themes in order to develop a sustainable city in the long term. Climate change prevention and preparedness, as well as alternative energy production, are strategies identified under the *Ensuring an environmentally sustainable city* theme.

At a more detailed level, the eThekwini Municipality has an Energy Strategy (eThekwini Municipality, 2008) which provides a framework for improving energy performance in the city. The DCCS builds on the content of this strategy and will ultimately replace the Energy Strategy once it is formally adopted. In addition to the Energy Strategy, a set of Municipal Adaptation Plans have been devised for the Health, Water and Disaster Management units of the eThekwini Municipality. Since the DCCS is intended to provide a framework strategy that guides and enables all sectors of society to respond to climate change, these sector specific Adaptation Plans will remain in place and be supplemented with additional plans as more municipal sectors address the challenge of climate change. The adaptation content of the DCCS has been aligned with these early pilot strategies.

EThekwini Municipality's Economic Development and Job Creation Strategy adopted in 2013 identifies 'transitioning to a green/low carbon economy' as a cross cutting principle and states that significant attention will be paid to the promotion of the green economy because of the potential local economic opportunities of this sector and the impact on climate change

mitigation (EThekwini Municipality, 2013). EThekwini Municipality has also initiated a process to develop a resilience plan for Durban. The purpose of the resilience plan is to better prepare Durban for the wide range of changes (both positive and negative) that cities of the 21st century will experience. Climate change is one of the key stresses that will be addressed by the resilience plan.

Chapter 6: Vision

The vision of the Durban Climate Change Strategy is:

> *"To transform Durban's governance, social, development and economic systems in order to effectively respond to climate change."*

The following mission statement has been developed to support the Vision:

> *"By 2020 there must be a fundamental change in Durban's governance, social, development and economic systems in order to contribute to the goal of limiting global average temperature increase to less than 2°C[8], minimising dangerous climate change and adapting to climate change impacts. This will be achieved by increasing the adaptive capacity of the city, enhancing the integrity of the city's environment and building a low carbon economy that provides sustainable livelihood opportunities and ensures well-being for all. All organisations and residents of Durban should be empowered to respond to climate change causes and its impacts."*

[8] Current target set by the United Nations Framework Convention on Climate Change (UNFCCC).

Chapter 7: Goals, objectives and responses

Ten interrelated climate change themes were identified through the strategy development process. This chapter outlines the goals, objectives and responses of these ten themes and forms the core of the Durban Climate Change Strategy (DCCS). The identified themes are:

Water	Energy
Sea level rise	Waste and pollution
Biodiversity	Transport
Food security	Economic development
Health	Knowledge generation and understanding

Under each theme, sectors responsible for implementation have been identified. The sectors identified include:

Sector	**Definition**
EThekwini Municipality	The local government responsible for planning and managing Durban. This includes the full range of eThekwini Municipal departments.
Provincial and other Local Authorities	KwaZulu-Natal provincial government departments, authorities and provincial entities such as Umgeni Water, catchment management agencies and neighbouring municipalities.
National Authorities	South African national government departments and national entities such as Eskom.
Business	Formal and informal businesses in Durban including commercial, industrial and agriculture businesses.
Residents	Residents of Durban.
Civil Society	Non-governmental organisations, faith based organisations, schools, community based organisations, ward committees and other civil society organisations in Durban.
Researchers	Any individuals and organisations involved in climate change related research relevant to Durban.

It should be noted that some of the themes in the Strategy are not always mutually supportive, with some responses that may be appropriate for a specific theme negatively impacting the objectives of a different theme. In order to limit such conflicts, a cross-sectoral approach is encouraged in the implementation of this Strategy, where partnerships and robust decision support mechanisms are used to enable informed and defendable actions. It should be further noted that there are several cross-cutting issues that have relevance across a number of themes, such as:

- **Land use planning and management:** Water, Sea level rise, Biodiversity, Food security, Economic and Transport themes include responses that reference the need to plan and manage land use in a way the promotes protection from climate change impacts and minimises GHG emissions.

- **Infrastructure and green buildings:** Water, Sea level rise, Health and Energy themes include responses that deal with the need to adapt infrastructure and buildings to respond to changes in climate, as well as the need to put in place measures to reduce the GHG emissions associated with the use of the infrastructure.

7.1 Water

Climate change is projected to alter rainfall patterns in Durban by intensifying rainfall variability. While average annual rainfall is expected to increase overall, this increased rainfall will generally be experienced through more intense storm events, resulting in more intense and frequent flooding. Drought cycles will also be more intense, resulting in increasingly severe water shortages. Given this projected increase in rainfall variability and intensity, existing dams may become inadequate to capture and store sufficient water for drier months and years. In addition, the stability and health of watercourses and streams may be affected by the more frequent and intense flooding. This could result in higher rates of siltation of dams and associated loss of water storage capacity, as well as a declining ability of freshwater ecosystems to process and absorb the pollutants discharging into them from urban and rural areas. Furthermore, increasing temperatures associated with climate change may result in more rapid rates of algal growth in freshwater ecosystems, causing more eutrophication in dams and rivers and declining freshwater quality. This declining freshwater quality, increasingly variable availability of freshwater supplies, and more intense and frequent flooding will result in greater costs to the municipality to supply potable water, and increasing health and safety risks to municipal citizens.

In light of this, water treatment, storage and distribution infrastructure is required to prepare for and protect against the impacts of climate change, make provision for vulnerable communities and assure adequate yields of good quality water to service all sectors of the economy (Schulze, *et al*., 2014). Informal communities that have become established in low-lying areas and flood plains are especially at risk from flooding, as are poor households whose houses are not resistant to extreme weather conditions.

Goal A: "*Durban's water resources and infrastructure are effectively managed to ensure optimal protection from climate change impacts.*"

Objective A.1: The impacts of climate change on the secure, clean and safe supply of water to Durban are minimised.	
Responses	**Implementing Sectors**
A.1.1 Facilitate co-operation between relevant agencies to jointly manage climate change impacts on catchments that supply water to Durban.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Business, Residents, Civil Society, Researchers.

A.1.2 Implement watershed management that responds to projected climate change impacts to optimise yields of clean freshwater and storage capacity in dams.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Business, Residents, Civil Society, Researchers.
A.1.3 Implement water demand management measures to reduce water demand in the face of projected climate change impacts.	EThekwini Municipality, Business, Residents, Civil Society, Researchers.
A.1.4 Adopt and enforce simple, innovative, adaptive engineering approaches to water treatment that respond to projected changes in water quality as a result of climate change.	EThekwini Municipality, Provincial and other Local Authorities, Researchers.
A.1.5 Recognise, make use of and manage the role that open spaces, natural areas and agricultural land can play in providing flood and storm water protection services.	EThekwini Municipality, Provincial and other Local Authorities, Civil Society, Researchers.
A.1.6 Prioritise water connections to communities that are most vulnerable to projected climate change impacts such as water scarcity and health risks.	EThekwini Municipality, Researchers, Civil Society.
A.1.7 Plan for projected increases in drought cycles as a result of climate change and introduce appropriate measures to maintain an acceptable assurance of water supply.	EThekwini Municipality, Provincial and other Local Authorities, Researchers.
A.1.8 Incorporate projected climate change impacts into proactive planning of the municipal water supply.	EThekwini Municipality, Provincial and other Local Authorities, Researchers.
A.1.9 Adopt a risk-averse approach to water quality protection by imposing stringent controls on water polluting land uses and activities to ensure that the impacts of climate change are not exacerbated.	EThekwini Municipality, Provincial and other Local Authorities, Researchers.

Objective A.2: The impact of amplified flooding and increased levels of storm water as a result of climate change is limited through risk-averse planning and appropriate infrastructure, building standards and enhancement of ecological infrastructure.	
Responses	**Implementing Sectors**
A.2.1 Adopt and enforce a risk-averse approach to spatial, land use and infrastructure planning and development controls that respond to potential climate change amplified flood risks.	EThekwini Municipality, Civil Society.
A.2.2 Research conducted into changes in projected rainfall and flood lines is incorporated into guidelines that are used when designing, planning and implementing all types of infrastructure. Considerations should include location of new infrastructure, infrastructure design and choice of materials.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Researchers.

A.2.3Adopt and enforce adaptive engineering approaches that are flexible and can evolve in response to changing threats and levels of flooding.	EThekwini Municipality, Researchers.
A.2.4 Identify and relocate existing critical infrastructure that is in areas of high flood risk to areas of lower risk.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Business, Researchers.
A.2.5 Identify and prioritise the relocation or upgrading of informal and low income settlements that are vulnerable to flooding.	EThekwini Municipality, Civil Society, Residents, Researchers.
A.2.6 Retrofit and modify existing infrastructure and public spaces using adaptive engineering approaches to provide protection against future water related climate impacts.	eThekwini Municipality, Provincial and other Local Authorities, National Authorities, Business, Civil Society, Researchers.
A.2.7 Monitor the effectiveness of storm water systems and upgrade where necessary to respond to variability in precipitation events and the projected increases in volumes of water and waste.	EThekwini Municipality, Researchers.
A.2.8 Incorporate the possibility of extreme water-related climate change events into the operational planning of the provision of basic services such as public transport, water, electricity, waste water management and refuse collection in order to prevent long term disruption of services and pollution of water bodies.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities.

7.2 Sea level rise

Durban is a coastal city and the impacts of climate change related sea level rise and increased coastal storms will impact directly on its economy, infrastructure and coastal communities (Mather and Stretch, 2012).

Sea level rise and the increased severity of coastal storms is a potential threat to the viability of Durban's plans to expand its port activities, the economic hub of the city. In addition, climate change is predicted to threaten the tourism industry as rising sea levels will reduce beach widths (a major tourist attraction) and damage tourism infrastructure. Rising sea levels will also lead to the loss of valuable public and private property and cause damage to prime and expensive seaside properties (Mather, 2013). Recent work by Rouault (2009) has predicted increasing wind speeds and ocean temperatures in the subtropical regions of the South Indian Ocean, which will result in increased storm events and wave heights, further exacerbating the effects of local sea level rise. The effect will be an increase in the frequency and magnitude of storms (Corbella and Stretch, 2012), which is likely to erode the shoreline, particularly in low lying areas and areas weakened by previous erosion (Theron, 2007).

Goal B: ***"Durban's protective coastal ecological infrastructure is maintained, restored and enhanced where possible to provide a buffer against sea level rise and coastal storms.***

Durban's coastal built environment is protected where appropriate, and further development is discouraged in high risk areas."

Objective B.1: The impact of sea level rise is limited through risk-averse planning and appropriate infrastructure, building standards and enhancement of ecological infrastructure.	
Responses	**Implementing Sectors**
B.1.1 Adopt and enforce the provincial coastal management line and risk zones to manage current and future development in the face of climate change.	EThekwini Municipality, Provincial and other Local Authorities.
B.1.2 Develop a coastal management policy for the management of the existing built environment in the face of climate change.	EThekwini Municipality.
B.1.3 Adopt and enforce a risk-averse approach to spatial, land use and infrastructure planning and development control that responds to all potential coastal flooding and other coastal risks.	EThekwini Municipality, Businesses, Civil Society.
B.1.4 Research, review and adapt infrastructure and building design standards to respond to current and future sea levels and coastal storm risks.	EThekwini Municipality, Researchers.
B.1.5 Adopt and enforce adaptive engineering approaches that are flexible and can evolve in response to changing threats and coastal erosion risk.	EThekwini Municipality, Researchers.
B.1.6 Prioritise the relocation or upgrading of informal and low income settlements that are vulnerable to sea level rise, coastal storms and coastal erosion.	EThekwini Municipality.
B.1.7 Relocate existing municipal buildings and infrastructure that are in high risk zone to areas of lower risk at the end of their economic life or when severely damaged by storms.	EThekwini Municipality.
B.1.8 Retrofit and modify existing buildings and infrastructure to provide protection against future sea level rise and increased coastal storms.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Business, Residents.
B.1.9 Recognise and make use, wherever possible, of the natural defence systems of coastal dunes to provide protection services against sea level rise, coastal storms and coastal erosion.	EThekwini Municipality, Researchers.

7.3 Biodiversity

Climate change is expected to have a substantial impact on Durban's biodiversity, ranging from impacts on genetic resources, to affecting the viability of species populations and the functioning of ecosystems. It will also influence the ability of natural capital to deliver a sustainable supply of high quality ecosystem services on which Durban's population and economy depends. Low income communities that are still directly dependent on ecosystem services for their livelihoods will be most at risk (EThekwini Municipality, 2011c).

Early climate modelling has suggested that increases in temperature and precipitation would decrease habitat suitability for a number of existing vegetation types and species, resulting in changes in the distribution and status of biodiversity. For example, the modelling has indicated that some terrestrial species may retreat inland. Increases in freshwater and ocean temperatures are also predicted to occur, with subsequent impacts on freshwater and marine habitats and species compositions. Changes in erosion and sedimentation cycles of coastal and freshwater habitats are also likely to result in changes in biodiversity (Roberts, *et al*., 2012; Golder Associates Africa, 2010).

The ability of species to move and / or adapt to changes in conditions is compromised by large scale transformation and fragmentation of the remaining terrestrial and freshwater ecosystems in Durban (Govender, *et al.*, 2009). It is estimated that 53% of the municipal area has already been transformed and that this is likely to continue to accelerate with future human population growth, development and urbanisation (eThekwini Municipality, 2011b). In addition, early climate modelling has indicated that climate change could favour the spread and competitiveness of certain invasive alien plants, resulting in further transformation and fragmentation of indigenous vegetation and habitats (Roberts, *et al*., 2012; Golder Associates Africa, 2010). As the remaining natural ecosystems are already negatively impacted by over-exploitation and pollution, the ability of natural ecosystems to respond and adapt to changes in local conditions due to climate change may be severely compromised.

Biodiversity also plays an important role in climate change mitigation through the capture and storage of carbon dioxide as a result of photosynthesis and biomass accumulation. Protecting and maximising biodiversity and ecosystems is therefore important for climate protection and the sustained supply of ecosystem services such as carbon sequestration.

Goal C: "*Durban's biodiversity and associated natural capital are protected and enhanced to deliver ecosystem services that facilitate protection from and mitigation of climate change.*"

Objective C.1: Ecosystem functioning and connectivity are enhanced through integrated planning and effective action to reduce climate change impacts on biodiversity and maximise the delivery of ecosystem services.	
Responses	**Implementing Sectors**
C.1.1.Maximise the extent and enhance the habitat representivity of Durban's network of public and private open spaces across a range of environmental gradients, to sustain viable species populations and to increase heterogeneity of species populations in order to improve resilience of species to climate change impacts.	EThekwini Municipality, Business, Residents, Civil Society.
C.1.2 Adopt and enforce integrated planning approaches and development controls that protect the integrity and enhance the functionality and resilience of Durban's biodiversity and natural capital to withstand climate change impacts.	EThekwini Municipality, Business, Residents.
C.1.3 Design and manage the built environment to contribute positively to the supply of ecosystem services, minimise pollution and degradation of the natural environment,	EThekwini Municipality, Business, Residents, Civil Society.

contribute towards biodiversity conservation and the sequestration of carbon dioxide.	
C.1.4 Ensure that linkages between open spaces are conserved and maintained to allow for poleward and altitudinal movement of plant and animal populations to ensure that gene flow and diversity are maintained, and that species are able to adapt to climate change impacts where such potential exists.	EThekwini Municipality, Civil Society.
C.1.5 Actively manage the spread of alien invasive species in freshwater, marine and terrestrial habitats to protect against the increased spread of these species as a result of climate change.	EThekwini Municipality, Civil Society.
C.1.6 Restore and manage degraded natural open spaces through government, business and community efforts to improve resilience of ecosystems to climate change impacts.	EThekwini Municipality, Business, Residents, Civil Society.
C.1.7 Acknowledge that there will be changes in biodiversity due to climate change and implement measures to manage the negative effects and enhance the benefits of these changes.	EThekwini Municipality.
C.1.8 Promote consideration of climate change impacts in the Environmental Impact Assessment process where it is likely that the development will affect the resilience or adaptive capacity of species, habitats or ecosystems to climate change.	EThekwini Municipality, Provincial and other Local Authorities.
C.1.9 Identify mechanisms for incentivising land owners to protect and manage natural environments on their properties to maximise ecosystem functioning and resilience in order to withstand climate change impacts.	EThekwini Municipality.
C.1.10 Prioritise the restoration, protection and management of habitats and ecosystems that are most vulnerable to the effects of climate change.	EThekwini Municipality.
C.1.11 Prioritise the restoration, protection and management of ecosystems that play a key role in alleviating the impacts of climate change on vulnerable communities or infrastructure.	EThekwini Municipality, Civil Society.
C1.12 Prioritise the restoration, protection and management of ecosystems that contribute towards mitigating climate change through carbon sequestration and storage.	EThekwini Municipality, Civil Society.

Objective C.2: Improve current understanding of climate change impacts on biodiversity through knowledge generation and stakeholder participation.	
Responses	**Implementing Sectors**
C.2.1 Identify climate sensitive indigenous species and develop appropriate strategies to protect and conserve these species under changing climate conditions.	EThekwini Municipality, National Authorities, Civil Society.
C.2.2 Adopt and enforce a precautionary or least regrets approach where climate change impacts are not yet currently understood, while continuously striving to improve the understanding of climate change impacts.	EThekwini Municipality.
C.2.3 Generate knowledge (including indigenous knowledge) of projected climate change impacts on biodiversity and ecosystem functioning through focussed research, monitoring	Researchers.

and evaluation.	
C.2.4 Identify existing or new invasive alien species that are likely to benefit from climate change and implement a control strategy to offset future impacts on biodiversity.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Researchers.
C.2.5 Identify commercially and socially important species and develop a plan to conserve these in response to changing climate conditions.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Researchers.
C.2.6 Develop local biodiversity and ecosystem conservation and management plans in a participatory manner with local stakeholders. The plans should address optimisation of carbon storage in ecosystems, protection of scarce or vulnerable species and habitats and optimise and sustain ecosystem services supply under conditions of climate change.	EThekwini Municipality, Business, Residents, Civil Society.

7.4 Food security

The projected climate changes for Durban, especially increases in temperature and severe weather events, are predicted to threaten urban food security in Durban. Declining food security is likely to disproportionately impact the poor (Ziervogel and Frayne, 2011), as the poor are more dependent on subsistence agriculture and are less likely to be able to purchase food at higher prices.

In response to these projections, it is important to develop a robust and resilient food security system that promotes sustainable local farming in order to increase regional food production and availability. Additionally, the system should support local food distribution, economic access to food and disseminate information that promotes the optimal utilisation of food. In light of extreme weather events, it is important for the city's food system to have the capacity to sustain communities affected by natural disasters (van Niekerk and van Niekerk, 2013).

Goal D: "*Durban has a robust and resilient food security system that ensures availability, equitable access to and efficient utilisation of food in the context of both climate variability and climate change.*"

Objective D.1: Durban has robust local food production systems that are able to withstand future climate threats and provide for the poor.	
Responses	**Implementing Sectors**
D.1.1 Develop and enforce polices and by-laws that reserve space for local food production.	EThekwini Municipality.
D.1.2 Encourage innovative local food production within urban development projects.	EThekwini Municipality, Business.
D.1.3 Localise food production and distribution through the establishment and preservation of agricultural hubs and small scale local community farming efforts.	EThekwini Municipality, Business.
D.1.4 Promote ecological and sustainable farming practices as	EThekwini Municipality,

an overarching approach to protecting local food production against climate change impacts.	Provincial and other Local Authorities, Civil Society.
D.1.5 Make use of indigenous knowledge in combination with latest research to educate communities and farmers about alternative, locally appropriate crops and farming techniques in order to continue producing food in Durban's changing climate.	EThekwini Municipality, Provincial and other Local Authorities, Civil Society, Researchers.
D.1.6 Encourage and support cooperation amongst small-scale growers so they are able to jointly respond to climate change challenges to food production.	EThekwini Municipality, Provincial and other Local Authorities, Civil Society.
D.1.7 Research the impacts of crop improvement technologies in the face of a changing climate.	Provincial and other Local Authorities, National Authorities, Researchers.

Objective D.2: Durban has adequate food distribution and marketing networks in place to adapt to climate change.	
Responses	**Implementing Sectors**
D.2.1 Promote the decentralisation of the fresh produce marketing system through a system of distribution hubs that can supply small traders more effectively and efficiently.	EThekwini Municipality, Business.
D.2.2 Establish food markets at transport hubs and centralised gathering points with local and other farmers supplying local communities.	EThekwini Municipality, Provincial and other Local Authorities, Business.
D.2.3 Provide support to informal traders in the food sector by conducting an analysis of what their potential needs are, i.e. micro-credit, shade, trading facilities that take account of climate change.	EThekwini Municipality, Business.
D.2.4 Provide refrigeration facilities at decentralised marketing hubs where small traders can pay for and store refrigerated food, thereby increasing the shelf life of foods and increasing the overall amount of food in storage.	EThekwini Municipality, Business.
D.2.5 Encourage large retailers to link directly to local and community producers where possible.	Business.
D.2.6 Investigate methods to improve the efficiency, adaptability and reduce the carbon footprint of food transport systems into and within Durban.	Researchers, Business.

Objective D.3: Durban residents have economic access to food in the face of climate change.	
Responses	**Implementing Sectors**
D.3.1 Investigate methods of increasing economic food access for climate vulnerable communities.	EThekwini Municipality, Civil Society.

D.3.2 Maximise the distribution to and utilisation of good quality leftover food waste by climate vulnerable communities.	Civil Society, Business.

Objective D.4: Durban residents are able to utilise foods appropriate for a changed climate in the best possible manner.	
Responses	**Implementing Sectors**
D.4.1 Educate people about the utilisation and preparation of crop types that may be more appropriate for production under changed climatic conditions.	EThekwini Municipality, Civil Society, Researchers.

Objective D.5: Durban is able to supply its residents with adequate food during climate related disasters or events.	
Responses	**Implementing Sectors**
D.5.1 Link with existing food banks and promote the establishment of more food banks.	EThekwini Municipality, Civil Society.
D.5.2 Consider a system of smaller, localised food banks or fresh produce hubs that are able to effectively supply food locally to extreme weather disaster affected households. Establish emergency rations storage at such facilities.	EThekwini Municipality, Civil Society.
D.5.3 Identify alternative methods for bringing food into Durban and for distributing food within Durban under emergency conditions that disrupt normal transport channels.	EThekwini Municipality.
D.5.4 Investigate modern emergency ration food preservation technologies/suppliers and promote a local industry around these.	EThekwini Municipality, Researchers.

7.5 Health

The effects of climate change on health are two-fold:

Firstly, climate change will directly affect the well-being of the region's population by increasing peoples' susceptibility to health risks. For example, rising temperatures in Durban are predicted to cause heat stress, respiratory diseases and cardiovascular diseases, and may exacerbate diabetes, mental problems and infectious diseases. The increase in rainfall, resultant floods and sea level rise in Durban is likely to lead to injuries, an increase in the prevalence of water-borne diseases, hunger and malnutrition. Drought is predicted to cause dehydration due to water shortages and water contamination. It will also reduce food supply and may lead to starvation (Hounsome and Iyer, 2006; Mather, *et al*., 2009; Mather and Stretch, 2012; Knoesen, *et al*., 2009; Schulze, *et al.*, 2010; Constable and Cartwright, 2009).

Secondly, climate change, and more specifically severe weather events, will affect the level of service provision rendered by the public departments responsible for water, transport, waste management and sanitation, and the health department itself, which will collectively result in inferior healthcare. The impacts will be felt more severely by the most vulnerable sub-population groups such as young children, the elderly, those with pre-existing diseases,

and those of poor socio-economic background (Ebi, *et al.,* 2006; World Health Organisation, 2008; Kjellstrom, 2009; Bell, 2013).The key challenge for the eThekwini Municipality is to increase the adaptability of, and plan for recovery and improvement of health service levels, particularly for the most vulnerable groups.

Goal E: "*Durban promotes public health and safety and the prevention of diseases in the face of a changing climate. Durban's public health system is resource efficient and climate smart.*"

Objective E.1: Promote healthy communities, populations and living environments that are prepared for the full range of climate change impacts.	
Responses	**Implementing Sectors**
E.1.1 Design and retrofit new and existing infrastructure, developments, public spaces and services to protect users from climate change related health impacts. Considerations include the appropriate location of new infrastructure, infrastructure design (such as improved shade at public places and transport nodes, building new houses that are thermally efficient and have cross ventilation, providing access to water at public spaces) and choice of materials to provide insulation from heat.	Ethekwini Municipality, Provincial and other Local Authorities, National Authorities, Researchers.
E.1.2 Identify communities that are vulnerable to high temperatures, floods and other climate-related events and develop and implement appropriate plans to reduce the vulnerability of these communities.	EThekwini Municipality, Researchers.
E.1.3 Identify and profile the sub-population groups most vulnerable to health impacts of climate change (i.e. those who cannot take care of themselves such as the aged, youth and persons living with disability).	EThekwini Municipality, Researchers.
E.1.4 Provide a support network for the aged, persons living with disability and any other sub-population groups that may require extra care and assistance as a result of climate change impacts.	EThekwini Municipality, Provincial and other Local Authorities.
E.1.5 Recognise, make use of and manage the role of open spaces and agricultural land in providing protection from urban heat islands and other climate impacts.	EThekwini Municipality, Civil Society.

Objective E.2: Strengthen and promote emergency management services to better handle emergency and disaster situations related to climate change and health.	
Responses	**Implementing Sectors**
E.2.1 Develop community emergency plans in response to possible climate related disasters that include use of early warning systems with associated public health advice.	EThekwini Municipality.
E.2.2 Equip local health facilities to handle climate related emergencies and extreme weather events in order to prevent or lessen referrals to tertiary health facilities. Ensure health facilities are able to function under climate related disaster conditions (i.e. potable water reserves, electricity generation	EThekwini Municipality, Provincial and other Local Authorities.

back-up, access even during floods, etc.).	
E.2.3 Establish adequate stockpiles of medications, medical supplies, assistive devices and other resources that may be required during climate change related disasters and events.	Provincial and other Local Authorities.

Objective E.3: Surveillance and monitoring of climate related diseases and associated vectors.	
Responses	**Implementing Sectors**
E.3.1 Introduce, enhance and integrate surveillance systems to monitor changes in climate and climate-related diseases. Systems should include a weather watch system/early warning systems and surveillance and accurate record keeping of climate related illnesses, such as heat-related illnesses and vector-borne, water-borne and food-borne illnesses.	EThekwini Municipality, Provincial and other Local Authorities, National Authorities, Researchers.
E.3.2 Community burden of diseases data should be updated where possible. This is particularly applicable for co-morbidities for climate-sensitive health outcomes.	EThekwini Municipality, Provincial and other Local Authorities.
E.3.3 Monitoring for conditions (e.g. tree cover, improved housing development, etc.) that enhance/reduce communities' vulnerabilities/resilience.	EThekwini Municipality, Provincial and other Local Authorities.
E.3.4 Integrate surveillance systems across departments and those of private organisations to provide a holistic view of climate change and health vulnerabilities within the city.	EThekwini Municipality, Provincial and other Local Authorities.

Objective E.4: Climate change and climate change responses take into account air quality and human health.	
Responses	**Implementing Sectors**
E.4.1 Ensure local energy generation projects conform to the Air Quality Management Plan and implement a range of mitigation measures to reduce impacts on local air quality.	EThekwini Municipality, Business.
E.4.2 Incorporate potential increases of mono-nitrogen oxides (NO_x) and volatile organic compounds (VOCs) as a result of increased temperatures into Durban's Air Quality Management Plan.	EThekwini Municipality.

7.6 Energy

Energy use can be broken down into two distinct components, namely transportation and stationary applications in the case of residential, commercial, industrial and municipal use. The former component is dealt with in the 'Transport' section of this strategy.

Energy for stationary applications is provided predominantly through electricity, which is generally distributed to users on a local grid that is owned and controlled by eThekwini Municipality. Almost all electricity used in Durban is generated outside of the city boundaries by Eskom. A very small proportion of energy is, however, generated locally through three

municipal landfill gas to electricity initiatives at Mariannhill and Bisasar Road landfill sites. Industrial users also make use of a number of other fuels such as refinery gas, bagasse, diesel and coal, to generate energy on-site for a variety of energy requirements. In addition, it is estimated that only 69.3% of households have access to formal electrification (eThekwini Municipality, 2014). The remaining households rely on a combination of illegal electricity connections and fuels such as paraffin, wood and liquefied petroleum gas (LPG). Many households that are connected to the electricity grid still use other fuels (such as biomass) to supplement their energy needs either because of financial constraints or preferences for alternative fuels (Euston-Brown, 2013).

Goal F: "*Durban has a thriving sustainable energy sector. Where appropriate, renewable energy supplies a significant proportion of Durban's energy needs, and energy is used efficiently by all sectors. All sectors have access to safe and affordable energy sources*."

Objective F.1: 40% of Durban's electricity consumption is supplied from renewable energy by 2030 in line with the national long term mitigation targets.	
Responses	**Implementing Sectors**
F.1.1 Develop and implement a road map for the supply of 40% of electricity from appropriate renewable energy technologies by 2030. A minimum of 10% of the electricity supplied from the national grid will be derived from renewable sources.	EThekwini Municipality, National Authorities, Researchers.
F.1.2 Implement viable small-scale renewable energy generation such as micro-hydropower, rooftop solar photovoltaic and anaerobic digesters within municipal assets.	EThekwini Municipality, Business, Civil Society, Residents.
F.1.3 Create an enabling environment for local energy generation that allows for connection of local generators to the grid.	EThekwini Municipality.
F.1.4 Introduce rebates and incentives to encourage electricity users to implement renewable energy technologies.	EThekwini Municipality.
F.1.5 Develop a Sustainable Energy Sector Development Plan to advance the sustainable energy sector of the green economy within Durban.	EThekwini Municipality, Business, Civil Society, Researchers.
F.1.6 Develop dedicated institutional structures and capacity within the Municipality that can support the uptake of renewable energy.	EThekwini Municipality.
F.1.7 Introduce a renewable portfolio standard (RPS) to increase production of energy from renewable sources.	EThekwini Municipality.

Objective F.2: Energy in Durban is used efficiently by all sectors.	
Responses	**Implementing Sectors**
F.2.1 Residents adopt a range of energy efficiency measures within their own homes. The target must be in line with the peak–plateau-decline scenario of the national Long-Term Mitigation Scenario. • By 2020, 50% of mid- to high income households have implemented efficient water heating	Residents, Civil Society.

technologies. • By 2017, 50% of mid- to high income households use gas or induction cookers for cooking. • By 2020, 90% of residential lighting is energy efficient.	
F.2.2 Businesses adopt a range of energy efficiency technologies with 90% of lighting, heating, ventilation and cooling (HVAC) and water heating equipment within facilities becoming energy efficient by 2030.	Business, Civil Society.
F.2.3 EThekwini Municipality adopts a range of energy efficiency technologies with 90% of lighting, heating, ventilation and cooling (HVAC), distribution systems, water and waste water treatment and water heating equipment within facilities becoming energy efficient by 2030.	EThekwini Municipality.
F.2.4 Promote programmes to implement energy efficient technologies and design in buildings and developments beyond existing national standards in local building regulations.	EThekwini Municipality, Business.
F.2.5 Introduce a range of mechanisms that reduce electricity consumption during peak hours.	EThekwini Municipality, Business, Civil Society.
F.2.6 Facilitate the uptake of energy efficiency incentives by energy users in Durban.	EThekwini Municipality, Business, Civil Society.
F.2.7 Develop and implement a range of programmes and competitions to promote large scale behaviour change towards energy efficiency in Durban.	EThekwini Municipality, Business, Civil Society.
F.2.8 Promote the use of energy efficient technologies to reduce the heat island effect in Durban's urban nodes.	EThekwini Municipality, Business.

Objective F.3: All Durban's energy users have safe access (physical access and social access) to suitable energy forms to meet their needs.	
Strategies	**Responsible Sectors**
F.3.1 Encourage a 'basket' of energy services to meet the energy needs of poor households and reduce the 'energy burden' or cost of energy.	EThekwini Municipality, Civil Society.

7.7 Waste and pollution

Although emissions from the waste sector are minimal, there is the potential for the waste sector to contribute to the reduction of greenhouse gas (GHG) emissions on a large scale through the prevention and re-use of waste, as this reduces emissions in other sectors in the supply chain, including extraction, production and transportation (UNEP, 2010). Durban's population is growing more affluent with increasing numbers of people moving into the middle class, a transition which is associated with increased levels of consumption and subsequent waste generation. This results in higher levels of waste generation and associated GHG emissions along the supply chain as demand increases (Fischer, 2013).

In terms of air pollution, one of the greatest challenges is in ensuring that climate change mitigation efforts do not increase air pollution at a local level. For example, there are concerns that efforts to reduce GHG emissions by promoting localised energy generation could increase air pollution within Durban. Climate change is also expected to cause a decline in air quality due to the fact that increased temperatures enhance ozone formation as a result of emissions from industrial processes (Fischer, 2013).

Methane is one of the more potent GHGs and is emitted from landfill sites and waste water treatment works. There is an opportunity to capture this methane for energy generation purposes and so reduce local GHG emissions (Fischer, 2013).

Goal G: "*Durban has effective air, water, solid waste and waste water management systems in which resources are focused on reduction, re-use and recycling strategies that effectively reduce greenhouse gas emissions in all economic sectors, divert waste from landfill, and create employment opportunities. Waste infrastructure is also designed appropriately to adapt to the impacts of climate change*."

Objective G.1: GHG emissions from waste and pollution generated in Durban are minimised.	
Responses	**Implementing Sectors**
G.1.1 Establish and integrate waste and pollution statistics collection systems relevant to GHG emissions.	EThekwini Municipality, Researchers.
G.1.2 Identify and control large emitters and polluters. Enforce the National Environmental Management: Air Quality Act (Act No. 39 of 2004) and Atmospheric Emission Licences.	EThekwini Municipality.
G.1.3 Enforce waste, water and air pollution legislation that assists in regulating GHG emissions.	EThekwini Municipality.
G.1.4 Reduce waste at source through innovative reduction approaches, such as making changes to the design of packaging in order to reduce the GHG emissions associated with waste along the value chain.	Business, Civil Society.
G.1.5 View waste as a resource and proactively identify opportunities for waste re-use by organisations and industries in order to achieve emission reduction targets.	Business, Civil Society, Residents.
G.1.6 Research the full lifecycle GHG emissions across the range of waste recycling and re-use options with a view to identifying the options that maximise emission reductions.	EThekwini Municipality, Researchers.
G.1.7 Operate a functioning separation-at-source recycling service that creates multiple job opportunities and is supported by well distributed recycling drop-off stations.	EThekwini Municipality.
G.1.8 Provide waste collection services in all residential areas to avoid the burning of waste and to prevent the pollution of natural resources.	EThekwini Municipality.

G.1.9 Minimise methane emissions through implementing the recovery of energy at landfill sites and waste water treatment plants, where viable, that conforms to environmental and air pollution standards. Methane that cannot viably be used for energy generation or transport should be flared.	EThekwini Municipality, Business.

7.8 Transport

Road and rail transport infrastructure in Durban is primarily aligned along two main corridors: the coastal corridor, which includes the N2 national road and coastal rail lines; and the western corridor, which includes the N3 national road and carries traffic between Gauteng and Durban (Mason-Jones, *et al*., 2014). The western corridor includes several long-distance pipelines that transport crude oil, fuels and gas between Durban and Gauteng (Transnet Pipelines, undated). The Durban port is the largest port in South Africa and the main port for freight moving to and from Gauteng (Mason-Jones, *et al*., 2014).

Urban passenger transport in Durban is strongly reliant on public transport, with only 36% of the population having access to a car (eThekwini Municipality, 2010). Despite this, private vehicles make up the largest segment of passenger transport, and car ownership has been growing steadily since 1985 (eThekwini Municipality, 2005). It is noteworthy that a significant proportion of trips (greater than 1 km) are made on foot and that minibus taxis have the largest share of the public transport market (Mason-Jones, *et al*., 2014). Low income groups generally travel on foot and by minibus taxi, which are less carbon intensive forms of mobility than private vehicles. There is, however, the potential for car ownership to increase as households begin to enter the middle class, which will have negative implications for future carbon emissions (Mason-Jones, *et al*., 2014). The modal split of trips greater than one kilometre taken in Durban is shown in the figure below:

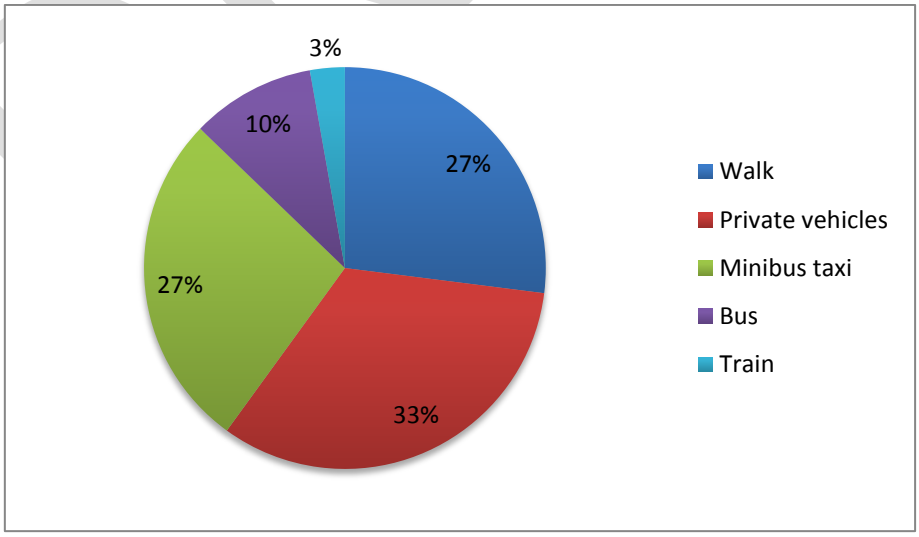

Figure 3: Modal split of passenger transport trips of greater than 1km (EThekwini Municipality, 2010).

Limited data is available for urban freight movements, but it can be assumed that the vast majority of urban freight transport within Durban is by road. Rail is used primarily to carry

goods to and from areas beyond the municipal boundaries. In recent decades rail has, however, lost much of its market share to trucking. Although the Dube Tradeport is intended to be a major air freight hub, the small volumes typical of air freighted commodities are not likely to impact significantly on other aspects of the freight transport system.

Goal H: "Durban provides an integrated climate smart, low carbon transport system for passengers and freight."

Objective H.1: Durban's spatial planning is integrated with transport planning to reduce the need for travel.	
Responses	**Implementing Sectors**
H.1.1 Develop economic nodes and mixed use zones in existing and planned neighbourhoods and communities where residents have access to shops, services and entertainment, thus reducing the need for extensive travel.	EThekwini Municipality, Business.
H.1.2 Improve transport linkages that enable access to goods and services between neighbourhoods, communities and economic nodes.	EThekwini Municipality.
H.1.3 Encourage densification within nodes and along public transport routes (and that respects that carrying capacity of the natural environment) to achieve economies of scale. Development outside of these nodes, public transport routes and the Urban Development Line should be discouraged.	EThekwini Municipality, Civil Society.

Objective H.2: All Durban's transport users have access to safe, affordable, carbon efficient and climate resilient transportation.	
Responses	**Implementing Sectors**
H.2.1 Provide and maintain efficient, high quality and safe road and rail infrastructure that supports low carbon, climate smart public transport options.	EThekwini Municipality, National Authorities, Provincial and other Local Authorities.
H.2.2 Maintain and extend high quality infrastructure that allows for safe movement by non-motorised transport.	EThekwini Municipality.
H.2.3 Continue with the implementation of the integrated rapid public transport network (IRPTN) in Durban to provide an affordable, high quality, clean and safe form of public transport that enables seamless movement between modes.	EThekwini Municipality, National Authorities.

Objective H.3 Greenhouse gases from transport in Durban are minimised and the energy efficiency of transport is improved.	
Responses	**Implementing Sectors**
H.3.1 Discourage private car use through a range of travel and trip demand management measures and behaviour change interventions.	EThekwini Municipality, Business, Civil Society.
H.3.2 Explore the adoption of a range of alternative fuels and fuel efficient technologies that are less carbon intensive.	EThekwini Municipality, Business, Residents.
H.3.3 Explore the local potential for adoption of energy	EThekwini Municipality,

efficient transport technologies.	Business, Residents.
H.3.4 Prioritise the use of and promote the purchase of low carbon and energy efficient vehicles.	EThekwini Municipality, National Authorities.
H.3.5 Optimise port operations by implementing a range of energy efficiency measures.	National Authorities.
H.3.6 Optimise freight rail systems and construct new infrastructure as required to improve rail accessibility and efficiency, in order to shift freight from road to rail.	EThekwini Municipality, National Authorities.

7.9 Economic development

Economic development is a priority focus for eThekwini Municipality. Durban's residents are affected by high levels of poverty, unemployment, high commuting costs and lack of skills, which limits their income generation capabilities. Global and local climate change introduces potential risks and opportunities for the Durban economy. For example, the risk of severe climate events impacting infrastructure, or the opportunity that lies in developing new economic sectors such as the renewable energy sector. EThekwini Municipality needs to promote the development of the local formal and informal economy so that it can reduce poverty within the context of an increasingly uncertain and risky future climate (EThekwini Municipality, 2013). EThekwini Municipality's Economic Development and Job Creation Strategy adopted in 2013 identifies job creation as key to reducing poverty and inequality (EThekwini Municipality, 2013). Importantly, the economy is both a major cause of climate change and a key solution for mitigating climate change impacts.

Various established and emerging concepts, such as sustainable development, low carbon and climate smart economies and the green economy, have become focal points for policy development within eThekwini Municipality. In facilitating the transition from the current unsustainable, high carbon and non-climate resilient economy to a climate responsive future economy, eThekwini Municipality will need to use the existing economic and legal instruments at its disposal and develop new tools that address the additional pressures created by climate change.

Goal I: "*Durban transitions to a low-carbon economy that is socially responsible and environmentally sustainable, provides diverse economic opportunities, and increases the capacity to adapt to the impacts of climate change.*"

Objective I.1: In the long term, Durban develops a low carbon economy that is socially responsible and environmentally sustainable.	
Responses	**Implementing Sectors**
I.1.1 Establish a platform, with an associated community of practice, to explore the climate change and economic development nexus.	EThekwini Municipality, Researchers, Civil Society.
I.1.2 Develop an understanding of the possible climate change scenarios and the potential roles which the economy may play (positive and negative) in each scenario.	EThekwini Municipality, Researchers, Civil Society.

I.1.3 Identify priority municipal responses through undertaking a risk and opportunities analysis for a range of climate change scenarios.	EThekwini Municipality, Researchers, Civil Society.
I.1.4 Define a set of policy outcomes that will achieve a low carbon and climate resilient economy that is socially responsible and environmentally sustainable.	EThekwini Municipality, Researchers, Civil Society.
I.1.5 Develop a suite of positive economic incentives that when applied will achieve the policy outcomes mentioned in 1.1.4.	EThekwini Municipality.
I.1.6 Develop municipal-wide indicators of progress to i) evaluate the efficacy of policies in achieving a low carbon and climate resilient economy, and ii) measure the welfare of the citizens of Durban.	EThekwini Municipality.
I.1.7 Conduct research into the relationships between potential economic growth options for Durban and the impacts of climate change, and what these relationships mean for a future Durban.	EThekwini Municipality, Researchers.

Objective I.2: In the short term, Durban implements a range of existing known interventions that can contribute to low carbon economic development.	
Responses	**Implementing Sectors**
I.2.1 Educate and promote the concept of localised production and the "circular economy"[9] within business where resources are preserved and re-used in the economy.	EThekwini Municipality, Business, Civil Society.
I.2.2 Create an enabling environment whereby businesses can network to establish symbiotic relationships with regards to the re-use of effluents, waste materials and other resources by other businesses.	EThekwini Municipality, Business.
I.2.3 Create income generation and commercial opportunities for vulnerable communities in the built environment in the restoration, protection and management of ecosystems through key partnerships.	EThekwini Municipality, Business, Civil Society.
I.2.4 Support the development of green products, services and industries sectors in eThekwini Municipality.	EThekwini Municipality, Business, Residents.
I.2.5 Promote and facilitate the promotion of low carbon micro-scale organic food businesses to provide economic opportunities to communities and reinforce food security.	EThekwini Municipality, Business, Residents.
I.2.6 Promote the efficient use of existing space, infrastructure and resources in Durban where brown fields developments are prioritised.	EThekwini Municipality, Business.
I.2.7 Ensure that the potential impacts of climate change are taken into account when considering large scale infrastructure projects.	EThekwini Municipality, Business, Civil Society.

7.10 Knowledge generation and understanding

Despite the fact that climate change has been identified globally as one of the key challenges of this century, the full scale of the likely impacts at the global, regional and local levels and what will be required to adapt to these impacts, are poorly understood. With regards to mitigation, viable and globally acceptable alternatives to the current carbon intensive development path have not yet been agreed on. The limited knowledge that is available on both adaptation and mitigation responses is not available or poorly understood by many Durban residents, and as a result they are unsure about how they contribute to climate change and what steps they should take to adapt to climate change.

Goal J: "*Durban has an engaged climate change research sector that generates regionally and locally relevant knowledge that is widely disseminated to all sectors in Durban for informed decision making and action.*"

[9] "A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair re-use and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models (World Economic Forum, 2014:15).

Objective J.1: High quality, innovative local climate change research is conducted on an on-going basis.	
Responses	**Implementing Sectors**
J.1.1 Establish a multi-disciplinary forum to promote the exchange of knowledge, cross-sectoral research, innovative local responses to climate change and increased capacity.	EThekwini Municipality, Researchers.
J.1.2 Research the full range of projected climate change impacts on natural resources, infrastructure and human well-being and appropriate adaptation measures for Durban.	EThekwini Municipality, Researchers.
J.1.3. Research the ecological thresholds of Durban's ecosystems to proactively define acceptable limits of human / settlement impacts on these systems in the context of climate change.	EThekwini Municipality, Researchers.
J.1.4 Conduct Mitigation Potential Analysis and develop Desired Emission Reduction Outcomes (DEROs) for each sector and subsector of the economy.	EThekwini Municipality, Researchers, Business.
J.1.5 Host an annual climate change research day.	EThekwini Municipality, Researchers.
J.1.6 Engage in knowledge sharing exchanges with other cities and local authorities to promote collective learning, sharing lessons learnt and best practice.	EThekwini Municipality, National Authorities, Provincial and other Local Authorities, National Authorities.
J.1.7 Provide opportunities for students to undertake research and gain qualifications that can contribute to the pool of knowledge necessary to respond optimally to climate change in Durban.	EThekwini Municipality, Researchers, Civil Society.

Objective J.2: People of Durban gain an improved understanding of climate change, its likely impacts and opportunities, as well as possible adaptation and mitigation measures relevant to their lives and their work areas.	
Responses	**Implementing Sectors**
J.2.1 Develop a range of audience-appropriate and innovative education and awareness resources to explain climate change, its potential impact on Durban, methods of reducing GHG emissions and how to adapt to changing conditions.	EThekwini Municipality, Civil Society, Researchers.
J.2.2 Develop a schools specific package of audience-appropriate information explaining climate change in the Durban context that links to the existing syllabus and can be presented in an exciting manner.	Civil Society, Researchers.
J.2.3 Develop and implement a targeted education campaign for communities that are most vulnerable to projected climate change impacts.	EThekwini Municipality, Provincial and other Local Authorities, Civil Society, Researchers.
J.2.4 Ensure eThekwini Municipality's departments and technical sectors understand the impacts of climate change and that staff are equipped to develop and implement appropriate adaptation and mitigation responses.	EThekwini Municipality.
J.2.5 Educate business, civil society and residents about the	EThekwini Municipality,

impacts that climate change will have on their businesses and communities, and that they are equipped with the tools and knowledge to respond optimally to these impacts.	Business, Civil Society.

Chapter 8: Implementation of the strategy

The implementation of the strategy will be led by the Environmental Planning and Climate Protection Department (EPCPD) and the Energy Office (EO) of eThekwini Municipality through the development of a separate Implementation Framework. This Implementation Framework will give effect to the ideals set out in this strategy and will provide a practical bridge to the Monitoring and Evaluation System.

The broad approach to implementation will entail the EPCPD and EO being responsible for mainstreaming the climate change strategy by promoting the introduction of climate change content into the Integrated Development Plan and Long Term Development Plan of the Municipality, as well as the relevant sectoral plans and policies of other municipal departments.

Since successful implementation requires cross-sectoral action, all sectors are encouraged to develop plans to implement the sections of the strategy that are relevant to their sectors. These sectoral plans should identify key performance indicators for key implementing agencies. In addition, formal linkages will be established with relevant provincial and national departments to ensure that local climate change responses are aligned with provincial and national efforts. To ensure that Durban's climate change response is integrated with that of its neighbours, partnerships will be formed with neighbouring municipalities to co-ordinate a regionally appropriate response to climate change.

In addition, this strategy has been developed through strong consultation with external stakeholders to ensure that it is a Durban-wide strategy, and encourages the level of buy-in and partnerships required to transition Durban into a low carbon, climate resilient city. Implementation will therefore include actions and contributions by a range of NGOs, CBOs, research institutions, specialists in the field of climate change, faith-based groups, etc.

EPCPD and EO will establish a system for monitoring the implementation of the strategy (See Chapter 9: for further details). The results of the monitoring and evaluation will be analysed on an annual basis and will be fed into a process of regular review of the strategy. Regular reviews of the strategy will be published and participation of the public in the review process will be promoted and facilitated.

Outlined below are the steps that will ensure the implementation of the strategy.

Objective K.1: Supporting strategy implementation.	**Implementing sectors**
K.1.1 Establish an inter-sectoral forum to promote partnerships between the sectors, support existing work in responding to climate change and to oversee the implementation of the DCCS.	EThekwini Municipality.
K.1.2 Develop implementation plans for each of the sectors that details the steps involved in implementing the responses of the DCCS.	All sectors.
K.1.3 Identify funding opportunities for the implementation of the key priorities of the DCCS.	All sectors.

Objective K.1: Supporting strategy implementation.	Implementing sectors
K.1.4 Identify and implement the six identified near term flagship programmes for Durban (see below).	EThekwini Municipality.
K.1.5 Promote alignment of the DCCS with the Integrated Development Plan and Long Term Development Plan of the Municipality, as well as the relevant sectoral plans and policies of other municipal departments.	EThekwini Municipality.
K.1.6 Establish partnerships with neighbouring municipalities, utilising existing structures such as SALGA, to promote a co-ordinated response to climate change in the broader region.	EThekwini Municipality, SALGA, ICLEI.
K.1.7 Establish a system to monitor and evaluate success in implementing the strategy.	EThekwini Municipality, Inter-sectoral forum.
K.1.8 Review municipal by-laws to identify revisions to ensure alignment with the DCCS.	EThekwini Municipality.
K.1.9 Publish an annual Monitoring and Evaluation report for the implementation of the strategy.	EThekwini Municipality.
K.1.10 Review the implementation of the strategy based on the result of the Monitoring and Evaluation report annually.	Inter-sectoral forum.
K.1.11 Revise the DCCS every five years.	Inter-sectoral forum.

As with the National Climate Change Response White Paper, a number of near-term Durban Flagship Programmes will be implemented to ensure that both mitigation and adaptation interventions take place as soon as possible. The Durban Flagship Programmes outlined below take into account the National Flagship Programmes, but also consider local priority intervention areas to ensure vertical integration between different spheres of government in responding to climate change. The six Durban Flagship Programmes are as follows:

1. **The Water Conservation and Demand Management Flagship Programme**

This programme will include the implementation of water demand management measures, including water recycling, to reduce water demand in the face of projected climate change impacts. It will also include the accelerated provision of rainwater harvesting tanks in rural and low-income settlements in the city.

Spearheading this programme is the uMngeni Ecological Infrastructure Programme, which focuses on investing in natural systems within the uMngeni River Catchment to improve ecosystem services, like improved water quality and supply derived from these systems.

2. **The Renewable Energy Flagship Programme**

This programme will include the development of a Sustainable Energy Sector Development Plan to advance the sustainable energy sector of the green economy within Durban. The programme will also include the piloting of renewable energy technologies in municipal infrastructure, such as solar photovoltaic installations and waste to energy installations.

3. **The Energy Efficiency and Energy Demand Management Flagship Programme**

This programme will consist of a number of sub-components including:

a) An aggressive energy efficiency programme in industry;
b) An aggressive energy efficiency programme in the residential sector;
c) An expanded solar water heating (SWH) programme;
d) A municipal buildings energy efficiency programme.

4. The Transport Flagship Programme

This programme will include participation in the National Energy Efficient Low-carbon Transport Programme which will see the development of an enhanced public transport programme to promote lower-carbon mobility in Durban. The programme will also include a Municipal Vehicle Efficiency Programme that will improve the efficiency of the City Fleet vehicles stock by 2020.

5. The Waste Management Flagship Programme

This programme will see the establishment of a waste and pollution statistics collection system relevant to GHG emissions. This will form the basis of a Waste-Related GHG Emissions Mitigation Action Plan.

6. The Adaptation Flagship Programme

This programme will see Durban acting as the Secretariat for the Durban Adaptation Charter (DAC), which aims to commit its 1,100 global signatories to the ten climate change adaptation principles contained within the Charter. Locally, the Central KZN Climate Change Compact is a partnership between eThekwini Municipality and its surrounding district and local municipalities for enhanced and integrated implementation of the ten DAC principles.

As part of the Municipal Climate Protection Programme, the city will also continue to implement its Municipal Adaptation Plans (MAP) in the Water, Health and Disaster Management sectors until these plans are integrated with their relevant themes within the Durban Climate Change Strategy. This will include representation of the MAP Technical Task Team in the Municipality's Disaster Management Advisory Forum.

Chapter 9: Monitoring and Evaluation

A monitoring and evaluation (M&E) system for the climate change responses outlined in this strategy will be developed in order to track progress in reducing climate vulnerability and transitioning to a low carbon city. The development of this M&E system is, however, dependent on two related pieces of work, namely the Durban Climate Change Strategy Implementation Framework and the National Climate Change Response Policy Monitoring and Evaluation System, and cannot therefore pre-empt these. The Durban Climate Change Strategy Implementation Framework will provide the link or bridge between the strategy and the M&E System. The development of the Durban Climate Change Strategy Monitoring and Evaluation System will therefore draw heavily on the Implementation Framework and retain links where appropriate to the National Climate Change Response Policy M&E System in order to facilitate ease of reporting.

Chapter 10: References

Bell, E.J. (2013). "Climate change and health research: has it served rural communities?" *Rural and Remote Health*, 13:2343, Available online from http://www.rrh.org.au, (Accessed 10 October 2013).

Constable, L. and Cartwright, A. (2009). "Climate change municipal adaptation plan for health and water", Report prepared for eThekwini Municipality, ERM, Available online from http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Publications/Documents/eThekwini%20Municipal%20AdaptationPlan%20-%20Health%20and%20Water%20-%2016.11.2009%20ERM090168.pdf, (Accessed 1 October 2013).

Corbella, S. and Stretch, D.D. (2012)."Predicting coastal erosion trends using non-stationary statistics and process-based models", *Coastal Engineering*, 70: 40-49.

Department of Environmental Affairs (DEA). (2011). "The National Climate Change Response White Paper", Government of the Republic of South Africa, Pretoria.

Ebi, K.E., Kovats, R.S. and Menne, B. (2006). "An approach for assessing human health vulnerability and public health interventions to adapt to climate change", *Environmental Health Perspectives*, 114(12):1930-1934.

EThekwini Municipality. (2005). "Public Transport Plan", EThekwini Municipality, Available online from http://www.durban.gov.za/City_Services/ethekwini_transport_authority/Documents/Public%20Transport%20Plan.pdf, (Accessed September 2013).

EThekwini Municipality. (2008). "EThekwini Municipality Energy Strategy", Volume 1 of 1, 6th February 2008.

EThekwini Municipality.(2010). "EThekwini Transport Authority Integrated Transport Plan Update, 2010-2015.", EThekwini Municipality. Available online from http://www.durban.gov.za/City_Services/ethekwini_transport_authority/Documents/itp.pdf, (Accessed September 2013).

EThekwini Municipality. (2011a). "A Survey of Municipal Services and Living Conditions", eThekwini Municipality.

EThekwini Municipality. (2011b). "State of Biodiversity Report", Environmental Planning and Climate Protection Department, Available online from http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Publications/Documents/Ethekwini%20Biodiversity%20Repor%2020102011t_FINAL.pdf, (Accessed: 13 May, 2014).

EThekwini Municipality. (2011c). "Durban, A Climate for Change, Transforming Africa's Future", Environmental Planning and Climate Protection Department, Durban.

EThekwini Municipality. (2012a). “EThekwini Municipality Draft Integrated Development, Five Year Plan: 2012/13 to 2016/17, 2012/2013 Plan”, Adopted by Full Council on 30th May 2012, eThekwini Municipality.

EThekwini Municipality. (2013). “Economic Development and Job Creation Strategy 2013”, eThekwini Municipality’s Economic Development and Investment Promotion Unit, Durban.

EThekwini Municipality. (2014). "EThekwini Municipality Integrated Development, Five Year Plan: 2012/13 to 2016/17”, Annual Review 2014/15.

EThekwini Municipality. (2014b). "EThekwini Greenhouse Gas Emissions Inventory: Technical Report”, Energy Office, eThekwini Municipality.

Euston-Browne, M. (2013). “Durban Climate Change Strategy Introductory Report: Sustainable Energy”, Sustainable Energy Africa, Prepared for eThekwini Municipality.

Forrest, C. Personal Communication. Researcher, Economic Development and Investment Promotion Unit, eThekwini Municipality. 1 July 2014.

Feiden, P. (2011). “Adapting to Climate Change: Cities and the Urban Poor, International Housing Coalition”, Washington. Available online from http://intlhc.org/wp-content/uploads/2011/09/Climate-Change-and-the-Urban-Poor.pdf, (Accessed 20 February 2013).

Fischer, T. (2013). “Durban Climate Change Strategy Introductory Report Theme: Waste and Pollution”, EScience Associates (Pty) Ltd, Prepared for eThekwini Municipality.

Global Insight Data. (2014a). Unemployment statistics for eThekwini Municipality, Provided by eThekwini Municipality’s Economic Development and Investment Promotion Unit, 01/017/2014.

Global Insight Data. (2014b). Gini coefficient for South African Metropolitan Municipalities, Provided by eThekwini Municipality’s Economic Development and Investment Promotion Unit, 28/08/2014.

Golder Associates Africa. (2010). “EThekwini Municipality Integrated Assessment Tool for Climate Change”, Prepared for the eThekwini Municipality, Report Number 10290-9743-13, Durban.

Golder Associates Africa. (2011). “Community-based Adaptation to Climate Change in Durban”, Prepared for the eThekwini Municipality. Report Number 11977-10286-9, Durban.

Govender, N., Smit, A.J. and Schoeman, D.S. (2009). “Aspects of the Ecology of Durban’s urbanised coastline”, Durban. South Africa.

Hounsome, R. and Iyer, K. (2006). “EThekwini Municipality, Climatic Future for Durban Phase II: Headline Climate Change Adaptation Strategy”, unpublished final report prepared

by the CSIR at the request of the Environmental Management Department, eThekwini Municipality.

International Council for Local Environmental Initiatives (ICLEI). (2014). "About the Local Government Climate Roadmap". Available online from http://www.iclei.org/climate-roadmap/home.html, *(*Accessed: 13 May, 2014).

Intergovernmental Panel on Climate Change (IPCC). (2013). "Climate Change 2013: The Physical Science Basis: Working Group I: Contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change", Available online from: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf, (Accessed 12 May 2014).

Intergovernmental Panel on Climate Change (IPCC). (2014a). "Fifth Assessment Report Working Group III: Summary for Policy Makers", Available online from http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf , (Accessed 17 May 2014).

Intergovernmental Panel on Climate Change (IPCC). (2014b). "Fifth Assessment Report Working Group II: Summary for Policy Makers", Available online from http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf, (Accessed 17th May 2014).

Intergovernmental Panel on Climate Change (IPCC). (2014c). "Climate Change 2014: Impacts, Adaptation and Vulnerability: Working Group II: Contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change.", Available online from http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap22_FGDall.pdf, (Accessed 12 May 2014).

Kjellstrom, T. (2009). "Climate change, direct heat exposure, health and well-being in low and middle income countries", *Global Health Action 2009*.

Knoesen, D., Schulze, R., Pringle, C., Summerton, M., Dickens, C. and Kunz, R. (2009). "Water for the future: Impacts of climate change on water resources in the Orange-Senqu River Basin". Report to NeWater, a project funded under the Sixth Research Framework of the European Union, Institute of Natural Resources, Pietermaritzburg, South Africa.

Mason-Jones, K., Rambaran, N. and Cohen, B. (2014). "Durban Climate Change Strategy Introductory Report: Transport", The GreenHouse, Prepared for eThekwini Municipality.

Mather, A.A. (2008). "Sea Level Rise and its likely financial impacts", *Journal of the Institute of Municipal Financial Officers*, 8 (3): 8-9.

Mather, A.A. (2013). "Durban Climate Change Strategy Introductory Report: Sea Level Rise", eThekwini Municipality.

Mather, A.A. and Stretch, D.D. (2012). "A perspective on sea level rise and coastal storm surge from Southern and Eastern Africa: A case study near Durban, South Africa", *Water*, ISSN 2071-4441.

Mather, A.A., Garland, G.G., and Stretch, D.D. (2009). "Southern African sea levels: corrections, influences and trends", *African Journal of Marine Science*. 31 (2): 145–156.

Roberts, D., Boon, R., Diederichs, N., Douwes, E., Govender, N., McInnes, A., McLean, C., O'Donoghue, S. and Spires, M. (2012). "Exploring ecosystem-based adaptation in Durban, South Africa: "learning-by-doing" at the local government coal face", *Environment and Urbanization*, 24(1): 167-195.

Rouault, M., Penven, P. and Pohl, B. (2009). "Warming in the Agulhas Current system since the 1980's.", *Geophysical Research Letters*, 36, L12602, DOI:10.1029/2009GL037987.

Scenario Building Team. (2007). "Long Term Mitigation Scenarios: Scenario Document", Department of Environment Affairs and Tourism, Pretoria, October 2007.

Schulze, R.E., Knoesen, D.M., Kunz, R.P. and van Niekerk, L.M. (2010). "Impacts of Projected Climate Change on Design Rainfall and Stream flows in the eThekwini Municipal Area", ACRUcons Report 62, School of Bioresources, Engineering and Environmental Hydrology, University of KwaZulu-Natal, Pietermaritzburg.

Schulze, R., Diederichs Mander, N. and Hughes, C. (2014). "Durban Climate Change Strategy Introductory Report: Theme Water", Prepared for eThekwini Municipality.

South African National Biodiversity Institute. (2014). "The Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa". Available online from http://www.sanbi.org/programmes/risks-threats-biodiversity/climate-change-and-bioadaptation-division/ltas, (Accessed: 13 May, 2014).

Statistics South Africa. (undated). EThekwini Municipality Statistics, Census 2011.Accessed online from http://beta2.statssa.gov.za/?page_id=1021&id=ethekwini-municipality, (Accessed 25 April 2014).

Statistics South Africa. (2014). Quarterly Labour Force Survey: Quarter 4 of 2013.

Theron, A.K. (2007). "Analysis of Potential Coastal Zone Climate Change Impacts and Possible Response Options in the Southern African Region". Proceedings of the IPCC-TGICA Workshop/Conference on Climate Change, Fiji.

Transnet Pipelines. (undated). Introduction, Available online from http://www.transnetpipelines.net/introduction.htm, (Accessed September 2013).

UNEP. (2010). "Waste and Climate Change, Global Trends and Strategy Framework", United Nations Environment Programme.

UN-Habitat. (2012). "State of the World's Cities 2012/2013, Prosperity of Cities", World Urban Forum Edition, United Nations Human Settlements Programme.

United Nations Development Programme. (2012). Income Gini coefficient, https://data.undp.org/dataset/Income-Gini-coefficient/36ku-rvrj, (Accessed 11 April 2011).

Van Niekerk, W. and van Niekerk, R. (2013). "Durban Climate Change Strategy Introductory Report Theme: Food Security", Africa Wide Consulting, Prepared for eThekwini Municipality.

World Economic Forum. (2014). "Towards the Circular Economy: Accelerating the scale-up across global supply chains aims to eradicate waste throughout the life cycles of products", World Economic Forum, Switzerland. Available online from http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf, (Accessed 9 May 2014).

World Health Organisation. (2008). "Heat-health action plans guidance", Available online, from http://www.euro.who.int/__data/assets/pdf_file/0006/95919/E91347.pdf, (Accessed 1 October 2013).

World Resources Institute. (2014), "Climate Analysis Indicators Tool (CAIT) 2.0", Total GHG Emissions including LUCF – 2010, Available online, from http://cait2.wri.org, (Accessed date 12 May 2014).

Ziervogel, G. and Frayne, B. (2011). *Climate Change and Food Security in Southern African Cities.* Urban Food Security Series No. 8. Queen's University and AFSUN: Kingston and Cape Town.