

**LOCAL GOVERNMENT'S RESPONSE TO CLIMATE CHANGE: CASE  
STUDY ON MITIGATION MEASURES WITHIN THE CITY OF  
TSHWANE**

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A research report submitted to the Faculty of Natural and Agricultural Sciences, Centre for Environmental Studies, University of Pretoria, in partial fulfillment of the requirements for the degree of Master of Science in Environment and Society

**July 2012**

## DISCLAIMER

I hereby declare that the research report,

**Local Government's response to Climate Change: Case Study on mitigation measures within the City of Tshwane,**

apart from the contributions mentioned in acknowledgements, is my own original work. It has not been submitted previously for any degree or examination at any other university.

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## ABSTRACT

Title: Local Government's response to Climate Change: Case Study on mitigation measures within the City of Tshwane

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Climate Change impacts cannot be managed in isolation from the dynamics of the broader societal challenges in terms of resource needs and utilization. Cities as the local sphere of government and the sphere closest to the affected communities, have competing priorities in terms of advancing actions that seek to reduce greenhouse gas emissions while providing basic services as mandated by the South African legislation such as, health care, transportation, access to water, electricity and waste services, to mention a few.

This study investigated how the City of Tshwane responded to the impacts of climate change through the implementation of programmes and projects that seek to mitigate greenhouse gas emissions. In gathering information on the City's responses, programme and projects managers responsible for climate change mitigation provided valuable information in terms of the City's efforts. The City's policy documents, as well as resources committed for implementation; both financial and human resources; were evaluated. The research also incorporated information from schools that benefitted from the practical training provided by the City on climate change mitigation, offering practical training on sustainable living with the environment. The key findings of the study were that most of the projects implemented by the City are within the energy efficiency thematic area and these are also prioritised in terms of financial and human resources allocated to them. The study also reviewed policies and strategies developed and the fundamental findings were that, these strategic documents did not feature climate change

mitigation and adaptation, which is a deficiency to be addressed through review, integration and mainstreaming.

### **Keywords**

Climate change, greenhouse gas emissions, mitigation, policies.

### **ACKNOWLEDGEMENTS**

My appreciation and gratitude is expressed to the following people, who inspired and encouraged me during this research study. I gratefully acknowledge the contributions made and in particular, I am grateful to:

- Dr. J Olwoch (Supervisor) for technical advice and guidance;
- The schools and officials of the City of Tshwane Metropolitan Municipality (CTMM) for their time and willingness to provide data related to this study in terms of questionnaires and relevant documentation;
- Prof. OJ Okonkwo who patiently guided and constructively criticized me;
- My Lord God, who carried me through this study;
- I am eternally indebted to my husband, my two daughters and my family – thank you for your love, patience, understanding, support and words of encouragement during the course of this study.

## 1. BACKGROUND AND INTRODUCTION

In the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (2007) Climate Change is defined as ‘a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer)’. The United Nations Framework Convention on Climate Change (UNFCCC) in its Article 1 defines climate change as ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’ (UNFCCC, 1992).

Goldie et al (2005) argues that ‘Climate change is a generic test of how we can cope with what is clearly an unsustainable situation’. It is evident and science has proven that levels of greenhouse gases in the atmosphere have risen over the years. This resulted in, an overall increase in air temperatures owing to human activities like the burning of fossil fuels (IPCC, 2007). The AR4 has also depicted a 70% increase in global greenhouse gas emissions as a result of anthropological activities between the years 1970 and 2004 (IPCC, 2007).

Lomborg (2001) describes global warming as the reason why the climate is changing, where warming is predicted through the greenhouse effect. He further explains the greenhouse effect to be caused by the “so-called” greenhouse gases which are responsible for trapping the heat from the earth and these include methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), chlorofluorocarbons (CFCs), ozone (O<sub>3</sub>) and water vapour. As much as these may be naturally occurring gases, increased consumption of natural resources and industrialisation release huge amounts of energy while increasing the amount of greenhouse gas emissions altering the composition of the atmosphere (Money, 1994).

The IPCC (2007) report stated “the warmest years in the instrumental record of global surface temperatures are 1998 and 2005, with 1998 ranking first in one estimate, but with 2005 slightly higher in the other two estimates” (IPCC, 2007). Figure 1.1 is an indication that global warming has accelerated over time with the first warming phase being between the 1900 to 1940 thereafter accelerating from 1960s to current. According to Reisinger (2009), greenhouse gas emissions by

humans are a major contributor to the observed increasing temperatures over the past 50 years impacting negatively on ecosystems and species. This is evident from the vertical pattern of warming as an attribution of increasing greenhouse gases, global rising sea level, loss of polar ice caps, temperature and precipitation extremes, changes in wind patterns as well as changes in patterns and longer trends in rainfall (Reisinger, 2009).

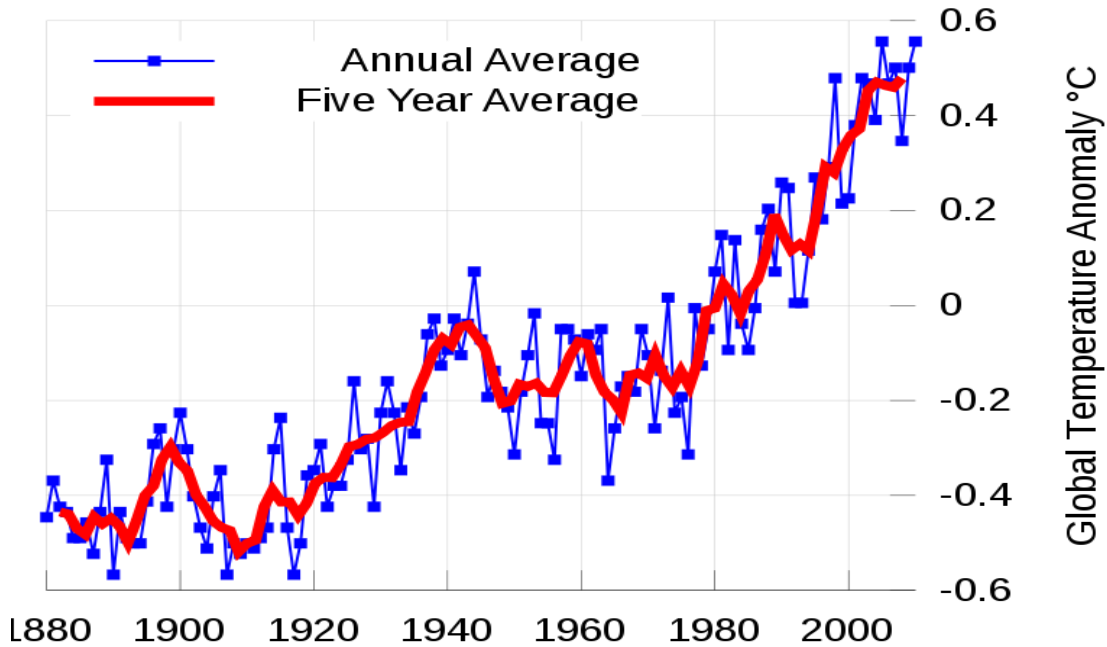


Figure 1.1: Global Mean Temperatures (Source: <http://commons.wikimedia.org/wiki/>)

The IPCC (2007) also indicated that ‘developing countries will suffer more than others as their lack of resources makes them especially vulnerable to adversity and emergencies on any major scale’ hence the urgency to reduce greenhouse gas concentrations in the atmosphere. Governments of states realised the importance of committing to greenhouse gas emissions reduction including the adoption of the Kyoto protocol, ‘...under which industrialised countries would have to reduce their combined greenhouse gas emissions by at least 5% compared to the 1990 levels by the first commitment period 2008-2012’ (UNFCCC, 1997).

One of the millennium development goals to be achieved by 2015 as set by the United Nations in the year 2000 is to ‘ensure environmental sustainability: reverse the loss of environmental resources- forests, biological diversity, the ozone layer ...’ (Sutton, 2007). This goal suggests

that without addressing the impacts of climate change, environmental sustainability is unlikely. The cold fact being that the warming of the earth will affect developing countries more than the industrialised, due to high levels of poverty in the former countries giving them less adaptive capacity (Lomborg, 2001). The fact that climate change occurs on a planet already occupied by humans, highly affects the resilience to climate change impacted by the extent of modification caused by humans. For example, how systems respond to climate change depends on local ecosystem factors which shape the resilience of a system (Adger, 2009).

The study by Mazo (2010) identified climate change mitigation, as an effort intended for greenhouse gas source reduction or sink enhancement while striving for environmental sustainability. This study has selected to focus on climate change mitigation measures since mitigation serve to reduce greenhouse gas emissions with global benefits rather than adaptation where benefits seems to be realised by an impacted system (Klein et al., 2007). Moomaw et al (2001) also suggest that emission reduction through different mitigation efforts can be measured and if the costs relating to those efforts are known, the cost-effectiveness can also be quantified and compared, while adaptation benefits depend mainly on the social, economic and political contexts within which they occur.

Since cities are urban areas, they have become the hub of economic activities; attracting a high density of the population seeking employment opportunities. Dawson et al (2006) also agrees that, a high density of people present potential vulnerability to the impacts of climate change such as flooding, drought and heat waves. The City of Tshwane as one of the South African cities is also affected by the climate variability and change challenges facing many other cities, with increasing population numbers, natural resource depletion and environmental degradation are inevitable hence the need for improved institutional arrangements including but not limited to the local sphere of government to enhance both vertical and horizontal flows of information (Zietsman, 2011).

## 1.1 Study Context

South Africa is among the top ten countries contributing to the global greenhouse effect and the fifteenth highest carbon dioxide (CO<sub>2</sub>) emitter as recorded in 1995 and 1997 (Blignaut & de Wit, 2004); hence a need for vigorous mitigation measures becomes highly imperative. In Figure 1.1 below, South Africa is shown as one of the world largest greenhouse gas emitters.

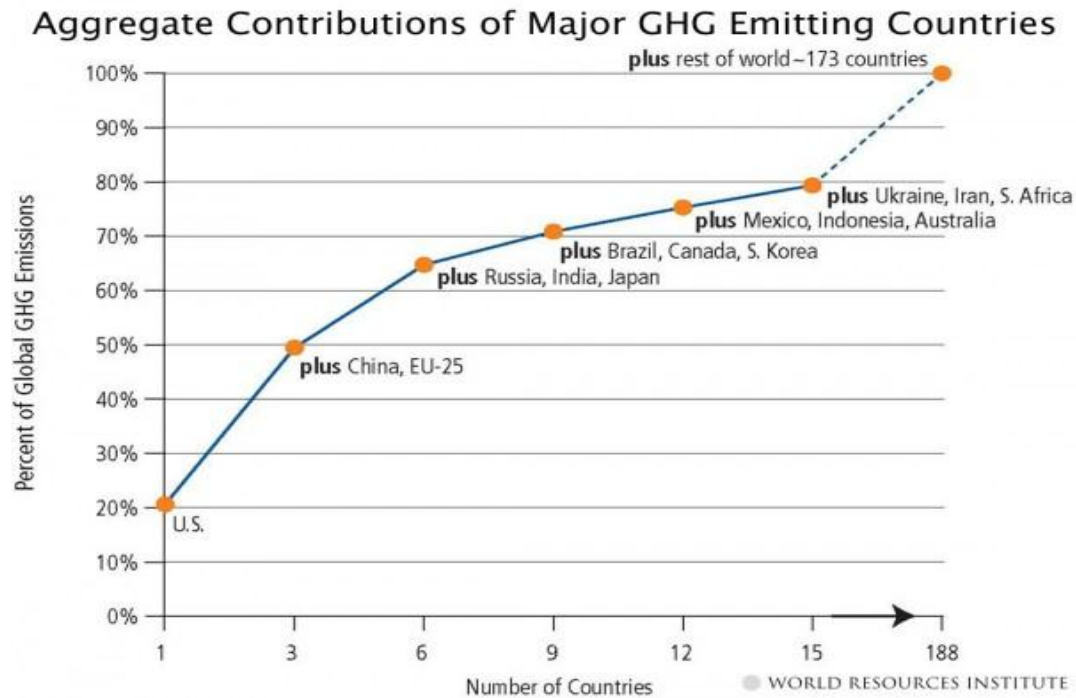


Figure 1.2: Largest Greenhouse Gas Emitters (Source: World Resource Institute)

According to Goldie et al (2005), the challenge of climate change is to ‘establish multiple connections between the knowledge generation process and the policy developers, and to conduct policy decision making in a more whole-of-government, quadruple bottom line framework’. This confirms the notion that climate change is not a national government’s domain but every sphere of government’s domain and more especially that of the implementing sphere of government; the local government.



According to the Constitution of the Republic, local governments are mandated to ensure the protection of communities they serve from unsustainable development practices and this is also supported by section 152 of the Constitution (1996) which lists the objects of local government with two critical objects stating that ‘local governments are to:

- Ensure the provision of services to communities in a sustainable manner;
- Promote a safe and healthy environment’.

Hence the local government plays a fundamental role in ensuring that greenhouse gas emissions are reduced. As the implementing authorities of government, local governments have to internalise the impacts associated with the delivery of services by including measures to reduce the impacts of greenhouse gases and climate change vulnerability through adaptation and mitigation measures. The role of local institutions in adaptation and mitigation efforts of different kinds cannot be undermined; without greater attention paid to these institutions, proves the success of mitigation and/or adaptation interventions and investments to be almost impossible (Adger et al., 2009).

A recommendation made by Oketh-Ogendo and Ojwang (1995) when addressing minimum response options, is that, responses to climate change need not be dependent upon new technologies, financial and human resources or capacity building. But emphasise that to ensure environmental sustainability, the society should be able to maintain a healthy state of equilibrium between resource availability and utilisation or consumption (Oketh-Ogendo & Ojwang, 1995).

## **2. PROBLEM STATEMENT AND SCOPE**

The City of Tshwane Metropolitan Municipality (CTMM) referred to in this study as the City; is pressured in fulfilling its mandate to deliver services to its inhabitants. As much as the City has developed the Tshwane Integrated Environmental Policy (TIEP) so as to manage its environmental performance as well as the Tshwane Local Authority Energy Strategy, commonly referred to as the Climate Change Strategy, it does not have an integrated approach to ensure the implementation of climate change mitigation programmes/and projects while fulfilling its mandate (CTMM, 2005). This has led to greenhouse gas emission reduction efforts being

managed in isolation to other developmental activities and may result in the City not being fully prepared to mitigate for climate change impacts.

In view of the problem statement, the research question to be addressed is:

***“How has the City responded to the impacts of climate change through mitigation?”***

## **2.1 Aims and Objectives**

The aim of the study is to investigate how the City has responded to climate change through implementation of programmes and projects that seek to mitigate greenhouse gas emissions with the following specific objectives:

1. To develop an inventory of emission reduction initiatives within the City;
2. To determine key constraints affecting the City in implementing climate change mitigation programmes/projects;
3. To provide recommendations on the effective implementation of mitigation measures responding to the effects of climate change within the City.

In order to address the research question above, climate change mitigation efforts, existing policy documents, as well as resources committed for implementation; both financial and human resources; were evaluated.

## **3. RESEARCH METHODOLOGY**

### **3.1 Study Area**

The selected study area is in the Gauteng Province, the City of Tshwane Metropolitan Municipality (CTMM) and it covers an area of 2 198 km<sup>2</sup>, divided into five (5) regions, namely the North East, North West, Central West, Eastern and Southern regions; and 76 wards (Figure

3.1; City of Tshwane locality map) (CTMM, 2006). The City is estimated to have 620 900 households (2005 estimate) with a population of 1 985 970 as per the census of 2001.

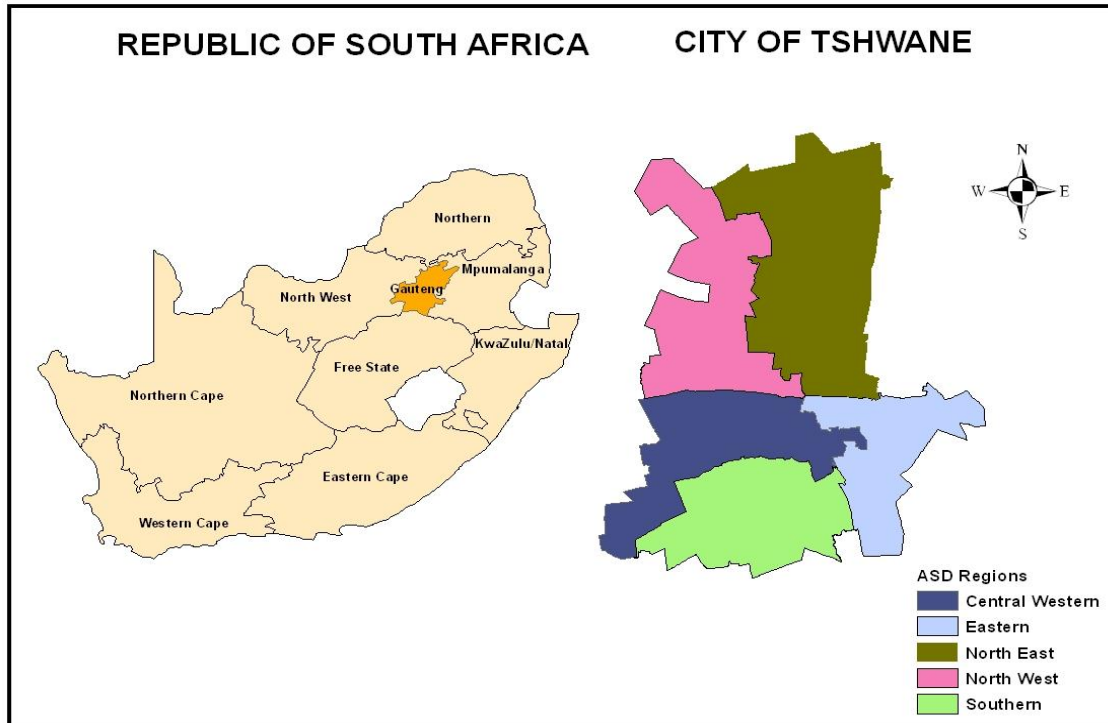


Figure 3.1: City of Tshwane Locality Map with five city regions (CTMM, 2006)

In terms of land uses, the Central North of the City is characterised by agricultural land use, while the Northern region has low density formal houses and is relatively undeveloped. The Eastern and Western regions are characterised by developed suburbs while the Southern region consist of mature infrastructure (CTMM, 2006).

According to Davis (2011), the South African climate is prone to extreme events such as droughts and floods occurring frequently, described as being predominantly within the semi-arid region with intra-seasonal and inter-annual rainfall variability. An increase in average temperature is projected to occur with an increase of very hot days for the period 2035 to 2065 (Davis, 2011). It is also indicated that temperature changes may result certain thresholds being reached causing huge impacts on both ecosystems and biodiversity (Archer, 2012). The City as an urban area with an increased population number; resulting a high demand for natural

resources emitting more carbon will be highly affected by temperature increases with different sets of scenarios with a range of possibilities (Archer, 2012).

## **3.2 Data Collection**

### *3.2.1 The Research Questionnaire*

A research questionnaire was developed, to gather information about climate change mitigation initiatives and challenges affecting the City in its mitigation efforts. In Vos et al, 2002; reference is made to the New Dictionary of social work (1995) which defines a questionnaire as “a set of questions in a form which is completed by the respondent in respect of a research project. The objective of a questionnaire as a tool for data collection is described by Vos et al (2002) as a means of obtaining facts and opinions about a particular subject from participants informed on the research topic.

The research questionnaire comprised questions related to:

- Emission reduction efforts within the City as well as those implemented by schools which participated in the climate change competition organised and coordinated by the City. The questionnaire, sought to obtain information on the City’s efforts at both a strategic and operational level in terms of planning and implementation of climate change mitigation measures; and
- The City’s and schools’ constraints in addressing climate change challenges; on which recommendations on different approaches towards mitigation and adaptation measures responding to the effects of climate change within the City would be based.

The research adopted a qualitative approach, in which knowledge claims would be made based primarily on constructivist perspectives (i.e. the multiple meanings of individual experiences, meanings socially and historically constructed, with the intent of developing a theory or pattern) or advocacy/participatory perspectives (i.e. political, issue-oriented, collaborative or change orientated) or both (Creswell, 2003).

The study also considered a quantitative approach where appropriate. This in view of Creswell (2003), is defined as ‘the one which the investigator uses post-positivist claims for developing knowledge’ (i.e. cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation and the test of theories) as it (this study) consist of interviews through a developed questionnaire to guide questions with key stakeholders, designed to gather qualitative data on the research questions. Yin (2012) acknowledge that qualitative and quantitative data are not two competing types of research but rather two types of data and can similarly be used in case study research.

Table 3.1 below lists both qualitative and quantitative research questions posed in the questionnaire:

*Table 3.1: Qualitative and Quantitative research questions*

<b>Qualitative research questions</b>	<b>Quantitative research questions</b>
What is your understanding of greenhouse gas emissions reduction?	How many projects that seek to mitigate climate change have you implemented?
Are you aware of a policy/strategy aimed at addressing the reduction of greenhouse gas emissions within the City?	Do you have a budget allocated towards the implementation of climate change mitigation programmes/projects? If Yes, how much?
Is the budget adequate to ensure the effective implementation of climate change mitigation programmes/projects? If no, give reasons why?	
Do you know of any training and awareness raising programmes related to climate change within the City?	
Have you received any training or been involved in an awareness raising programme?	
Do you have any programmes/projects aimed at the reduction of greenhouse gas emissions?	

Who is the source of funding climate change programmes/projects?	
Do you have any capacity dedicated towards the implementation of these projects?	

The phases of data collection were divided as follows, the first phase was the distribution of a questionnaire to various key stakeholders, that is, project initiators, implementers and programmes/projects’ managers so as to gather and clarify information on the research questions including greenhouse gas emissions reduction and climate change mitigation constraints. These are City of Tshwane officials who were previously involved and participated in the projects aiming at greenhouse gas emission reduction. These officials represents a population of the eleven (11) key departments and divisions within the City responsible for infrastructure based and “greening” type of projects aimed at mitigating climate change as well as reducing greenhouse gas emissions.

The key departments and divisions were identified through the Performance Management Office of the City. These departments and divisions are responsible for climate change mitigating projects which are managed by one official within the respective department or division. Fink (2003) suggests that, the inclusion criteria within a study should be established so as to determine the study population, and in this instance being the project managers and coordinators of climate change mitigation projects.

The questionnaire was also sent to schools, in both semi urban and rural regions of the City as shown on Figure 3.2 below, as the north-east, north-west and central western regions. The inclusion and exclusion criterion as recommended by Fink (2003) was also applied when schools were selected and hence a population of thirty-two (32) schools with only twenty-seven (27) participating in the study. These are the schools that benefitted from the practical training provided by the City on climate change mitigation, offering practical training on sustainable living with the environment and made a population that related to the purpose of this research study (Balnaves & Caputi, 2001).

The practical training was divided into two phases where phase one focused on educating learners and teachers on climate change, contributing factors and actions that seek to mitigate for climate change. While the phase two of the training required schools to demonstrate their understanding of climate change mitigation by initiating projects that would seek to mitigate for climate change. Schools were then eligible to participate in the City initiated climate change competition as an incentive to the schools' efforts. The questionnaire sought to determine mitigation efforts undertaken by schools from the aforementioned regions (see Table 3.3 below).

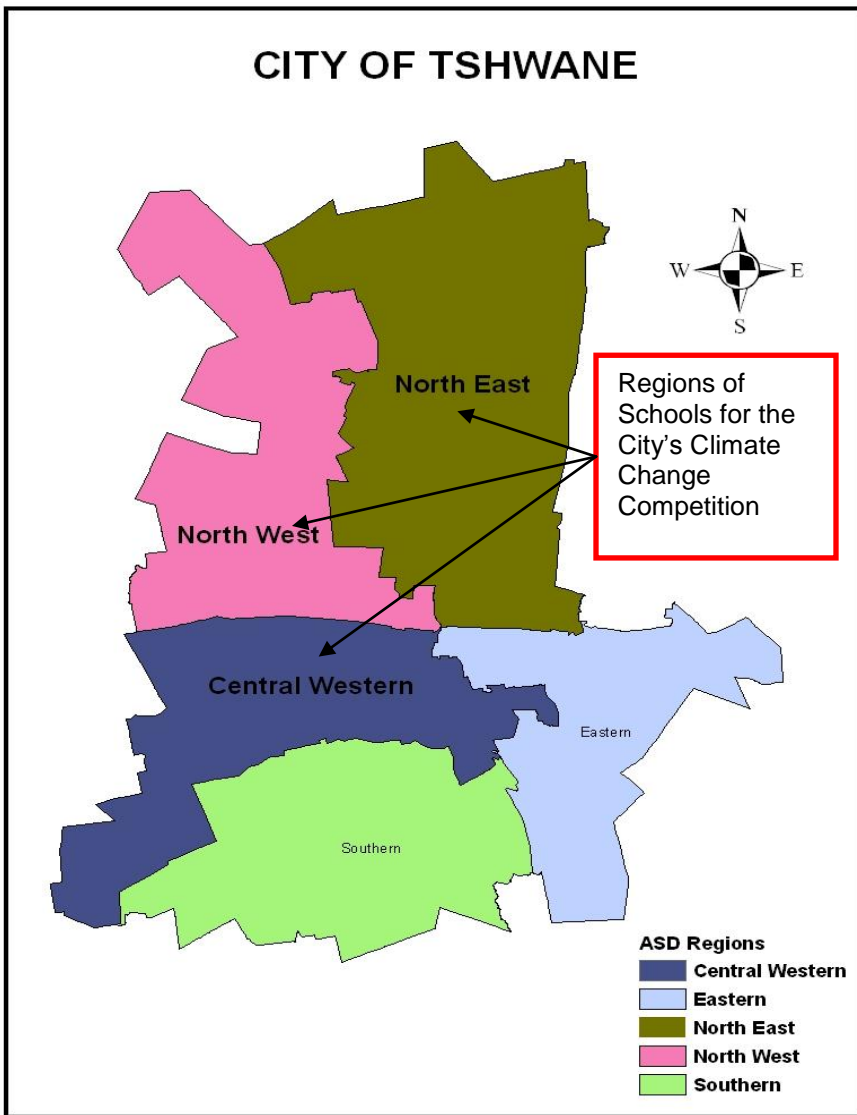


Figure 3.2: City of Tshwane Regional Map (CTMM, 2006): Participating schools from the North East, North West & Central Western Regions

### *3.2.2 Desktop study of City Policies and Strategies*

The second phase of the study focused on the review of documentation related to the research topic with the aim of analysing how the city has incorporated climate change mitigation and/or adaptation in its planning processes and policies. Since Cowie (2006) suggest that population growth demands more resources, elevating the pressure for the provision of basic services, housing, energy, water and sanitation, this study sought to investigate what the City has done in the past five years to address the increasing greenhouse gas emissions resulting from the increasing need for more resources.

According to Yin (2003), documents review is crucial in strengthening evidence from other sources. Since they are an ‘unobtrusive’ means of data collection, as suggested by Marshall and Rossman (1995), the City’s policies and strategic documents were not developed as a result of this study but existed prior to the undertaking of the research study.

Official documents and reports related to the research topic were reviewed with the intention to elicit information on climate change mitigation and greenhouse gas emissions reduction initiatives within the context of the City. These included amongst others, the Integrated Development Plan of the City (IDP), the Tshwane Integrated Environmental Policy (TIEP) with its implementation plan, which is an approved environmental policy of the City. These documents were reviewed so as to establish action plans made in terms of climate change mitigation.

Based on the TIEP, the City developed the Tshwane Local Authority Energy Strategy of 2006, aimed to focus on an integrated Sustainable Energy and Climate Change Strategy linking to the Air Quality Management Plan of 2006 (CTMM, 2006). The strategy was based on the State of the Energy report which covered energy uses within the City as well as the evaluation of greenhouse gas emissions. The Air Quality Management Plan of 2006 was also reviewed and it captured the reduction of greenhouse gases as part of the City’s climate change protection



programmes as one of its main goals (CTMM, 2006). The plan also identified the different strategies in terms of how it intends to achieve the goal on greenhouse emissions reduction.

### 3.2.3 Participants in the Study

The questionnaire was distributed by email to City departments (see Table 3.2) responsible for the management and implementation of climate change mitigation programmes/projects as well as schools (see Table 3.3) that participated in the 2010 and 2011 climate change competition. The questionnaire was also supplemented by interviews to obtain further information required as well as to clarify questions where such a need was identified.

*Table 3.2: City Departments as Research Project Participants*

<b>Participant</b>	<b>Field of Work</b>	<b>Method of communication</b>
001	Sustainable Energy & Climate Change	Questionnaire by email and personal discussion
002	Environmental Education (Climate Change Management)	Questionnaire by email and personal discussion
003	Air Quality Management	Questionnaire by email and personal discussion
004	Energy & Electricity	Questionnaire by email and personal discussion
005	Agricultural Development Programs	Questionnaire by email and personal discussion
006	Land Use Planning and Development	Questionnaire by email and personal discussion
007	Environmental Management	Questionnaire by email and personal discussion
008	Transport Planning	Questionnaire by email
009	Roads and Storm Water Management	Questionnaire by email
010	Housing and Sustainable	Questionnaire by email

	Settlement	
011	Waste Management	Questionnaire by email and personal discussion

*Table 3.3: Schools participated in the Climate Change Competition: Research Project Participants*

<b>Participant</b>	<b>School</b>	<b>Method of communication</b>
001	Baleseng Secondary	Questionnaire by email and personal discussion
002	Soshanguve South Secondary	Questionnaire by email and personal discussion
003	Ruabohlale Secondary	Questionnaire by email
004	Rhulani Combined school	Questionnaire by email
005	Vukosi Primary School	Questionnaire by email and personal discussion
006	Khensani P School	Questionnaire by fax
007	Semphato Secondary School	Questionnaire by email and personal discussion
008	Thakgalang Secondary School	Questionnaire by fax
009	Tebogwana Secondary	Questionnaire by fax
010	N.M Tsuene High	Questionnaire by email and personal discussion
011	Setlalentoa High School	Questionnaire by email
012	Bachana Mokwena P.S	Questionnaire by email
013	LG Holele High School	Questionnaire by email
014	Galeboe Secondary	Questionnaire by email and personal discussion
015	Abel Motshwane Middle School	Questionnaire by email and personal discussion
016	Dr. Sam Motsuenyane	Questionnaire by email
017	D.A Mokoma Secondary	Questionnaire by email
018	Ngaka Maseko High	Questionnaire by fax
019	Dr WF Nkomo Secondary S.	Questionnaire by email
020	Hofmeyr Secondary School	Questionnaire by email and personal discussion
021	Phelindaba Secondary School	Questionnaire by email
022	Edward Phatudi Secondary School	Questionnaire by email

023	Banareng Primary School	Questionnaire by email and personal discussion
024	Flavius Mareka High School	Questionnaire by email
025	Adam Masebe Secondary School	Questionnaire by email
026	Dilopye Middle School	Questionnaire by email
027	Tsebe Ntsha Secondary School	Questionnaire by email

### 3.2.4 Classification of Climate Change Projects

Climate Change mitigation projects/programmes implemented by the City and schools were visited and classified into the different thematic areas, which included, energy efficiency, water efficiency, emission reduction, waste minimisation and transport. The different projects implemented by the City as listed in Table 3.4 were verified during field visits.

However, projects implemented by schools were within the thematic areas of energy efficiency, waste minimisation and water efficiency. This was a minimum prerequisite for the schools to be eligible to enter the City's 2010/2011 climate change competition.

*Table 3.4: CTMM Climate Change Mitigation Programmes/Projects*

<b>Project</b>	<b>Project thematic area</b>
1. Retrofitting of Municipal Buildings	Energy Efficiency
2. Retrofitting of 2 Billboards with solar energy (Figure 3.3)	Energy Efficiency
3. Retrofitting of 13 Streetlight to solar energy (Figure 3.4)	Energy Efficiency
4. Retrofitting of 1 traffic signal to solar energy (Figure 3.5)	Energy Efficiency
5. Installation of solar water heaters in Winterveldt, Soshanguve and Olivenhoutbosch	Energy Efficiency
6. Installation of 2730 solar water heaters	Energy Efficiency

7. Retrofitting of streetlights with Compact Fluorescent Lights (CFLs)	Energy Efficiency
8. Retrofitting of traffic lights with LED	Energy Efficiency
9. Distribution of 1.9 million CFLs	Energy Efficiency
10. Air Quality Monitoring Network	Emission reduction
11. 7km Bicycle lane in Atteridgeville	Transport (non-motorised) – Emission reduction
12. Follow the smoke campaign	Emission reduction

Figure 3.3 to 3.5 below shows examples of some of the projects implemented within the City.



Figure 3.3: Retrofitted Billboard operating by solar energy – Corner Troye and park Streets (Arcardia)



*Figure 3.4: Street lights fitted with solar panels along Queen Wilhemina Street, Brooklyn*



*Figure 3.5: Traffic light on corner of DF Malan and Church Street operating by solar energy*

## **4. RESULTS AND DISCUSSION**

This section is informed by the results of the research questionnaire as well as climate change mitigation initiatives by the City and schools, which were visited and verified. Also evaluated and discussed are the City's reviewed policy and strategic documents. Proposed initiatives that the City should be intensifying to greatly reduce the impacts of climate change are also discussed.

### **4.1 Mitigation Measures / Emission reduction initiatives by City and Schools**

The information gathered from participants, from both City and schools was used to determine the City's and schools' initiatives in mitigating for climate change as well as to determine constraints in mitigating climate change impacts. Participants from the City are those who have been involved in the planning and implementation climate change mitigation projects, and have indicated the City's mitigation strategy to have focused on the implementation of energy efficiency projects more than any other thematic area. This is evident from the number of energy efficiency projects prioritised by the City in terms of financial and human resources.

These projects are mainly funded internally by the City and form part of the City's Integrated Development Plan (IDP). Due to the nature of these projects being infrastructure projects, which is what the City would refer to as 'capital' projects; funds were made available to ensure performance and service delivery by the City on these projects (CTMM, 2005).

Participants from City Departments have indicated that strategic documents such as the City's IDP have not considered climate change mitigation and adaptation aspects as part of the IDP. Therefore, mainstreaming at a strategic level is recommended.

An important factor to be noted is that Climate Change mitigation projects included in the IDP are those aimed at reducing the consumption of electricity. The rationale behind the inclusion of these projects is not necessarily climate change mitigation but rather electricity consumption reduction which is not a bad initiative, but a factor that requires remediation through policy and

other measures (CTMM, 2005). Crawford and French (2008) also confirms that in developing policies for carbon management, it is necessary that targets for the production of renewable energy are set, so as to achieve low carbon development.

An element resulting from the questionnaire in terms of projects that form part of the IDP projects is that as much as funds are secured for all IDP projects, not all with a focus on climate change mitigation get to be implemented. This is mainly due to lack of planning and prioritisation, top management commitment, projects not seen as service delivery orientated projects. For example, a project on retrofitting of streetlights to energy efficient light bulbs will not be seen as a priority compared to a waste collection infrastructure project. This is as a result of the long term benefits of the former not viewed as a priority compared to the 240 litre bins that could generate revenue for the City through waste collection.

Figure 4.1 below depicts projects implemented by the City as well as the thematic areas of these projects.

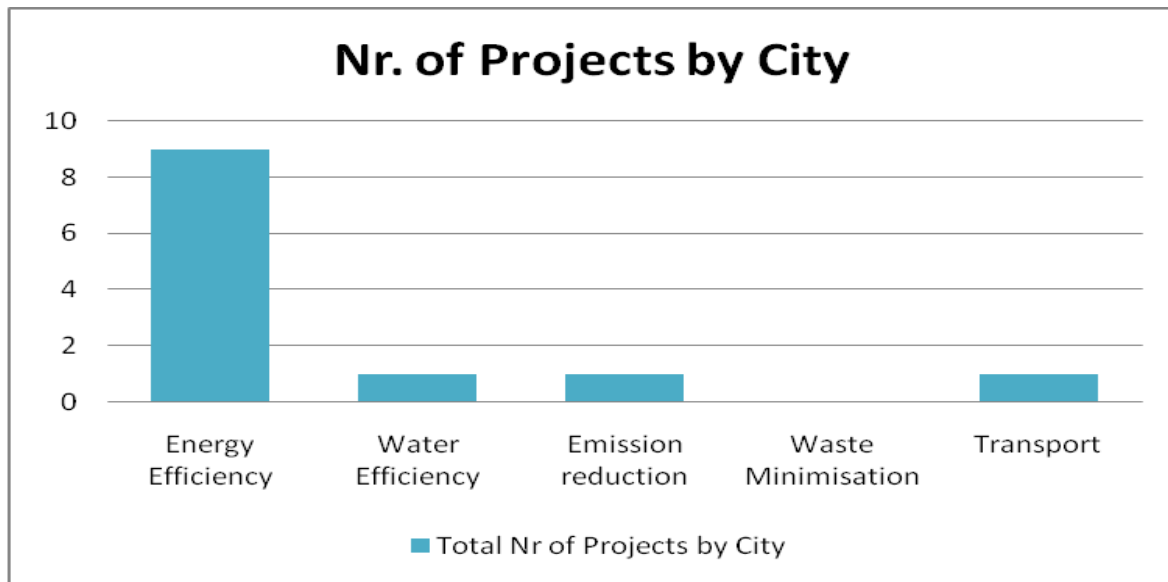


Figure 4.1: Climate Change mitigation initiatives by the City

The climate change competition initiated by the City for schools that participated in the study, required schools to demonstrate their understanding of climate change mitigation by implementing projects in three thematic areas as a minimum, namely; water efficiency, energy

efficiency and waste minimisation. The projects initiated by schools focused mostly on energy efficiency motivated by financial savings that can be made on the municipal bill for electricity. However some schools indicated that waste minimisation is also a priority as they understood that it yielded immediate results in terms of a cleaner environment, compensation for the recyclables and reduced waste to be disposed of at landfill sites.

The challenges highlighted by schools included, lack of support from the Department of Education to sustain these type of project, for instance a water efficiency project will require retrofitting to be done and the lack of financial resources revealed to be the biggest challenge in voluntary implementation of climate change mitigation initiatives. Figure 4.2 is an indication of the type of projects implemented by schools in their effort for climate change mitigation.

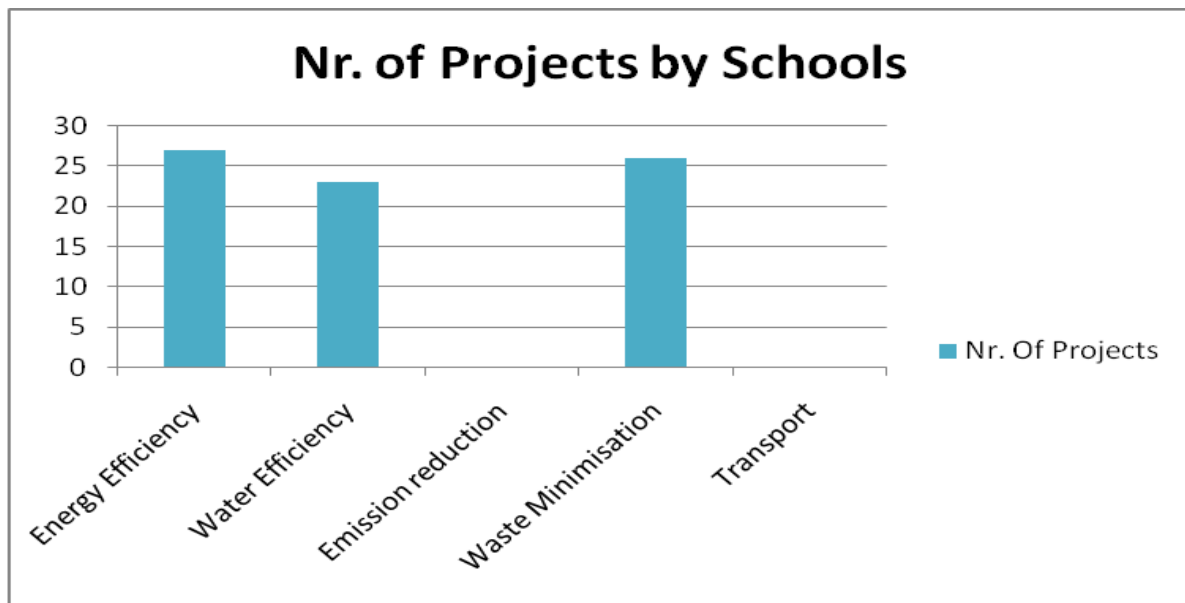


Figure 4.2: Climate Change mitigation initiatives by schools

## 4.2 Climate Change Mitigation Challenges: City and Schools

The findings made in terms of climate change mitigation challenges and proposed initiatives aiming at mitigation has been summarised in Table 4.2 and described under 4.2.1 and 4.2.2 below.



#### 4.2.1 Climate change mitigation constraints

Some of the main constraints hampering the City’s response to climate change through mitigation have already been highlighted in Table 4.2.

*Table 4.2: Summary on Climate Change Mitigation Challenges: Results from Questionnaires and Interviews*

City Participants	Schools Participants
Rationale of Projects initiated	
<ul style="list-style-type: none"> <li>• Driven by service delivery, revenue generation for the City</li> </ul>	<ul style="list-style-type: none"> <li>• Driven by immediate needs, for example, a cleaner environment</li> </ul>
Constraints	
<ul style="list-style-type: none"> <li>• Fragmented policies</li> <li>• Lack of commitment by top management</li> <li>• Competing priorities</li> <li>• Lack of financial resources</li> <li>• Lack of human resources</li> <li>• Lack of capacity (know-how)</li> </ul>	<ul style="list-style-type: none"> <li>• Climate Change management not part of the curricula</li> <li>• Lack of support by the Department of Education</li> <li>• Lack of environmental awareness</li> <li>• Lack of financial resources</li> </ul>
Proposed Initiatives for climate change mitigation	
Prioritisation of projects in the following thematic areas in this order: <ul style="list-style-type: none"> <li>• Energy Efficiency</li> <li>• Non-motorised transport</li> <li>• Efficient Public Transport Infrastructure</li> <li>• Waste minimisation</li> </ul>	Focus should be on projects in the following thematic areas: <ul style="list-style-type: none"> <li>• Waste minimisation</li> <li>• Water efficiency</li> <li>• Energy Efficiency</li> </ul>

The findings made by the study is that; participants from the City highlighted fragmented policies to be the main challenge in terms of initiatives that seek to mitigate climate change in a sense that most developmental policies within the City are not climate change sensitive. For instance, a participant from Land Use Planning and Development stated:

“Our policies are not aligned making it difficult for us to discourage unsustainable development and projects impacting on the environment.”

Lomborg (2001) suggest that in designing an alternative course of development, climate policy may be used as a tool and justification, he further state that in consideration of environmental scarcities, this alternative course, need to focus on eco-efficiency, industrial ecology and eco-efficient consumption of resources.

It has also become apparent from comments made by all participants, that there is a lack of commitment from top management. The staff turnover at this level of management also aggravates the problem. In a study conducted by Peters et al (2010) it is indicated that to achieve best practice at a local level on actions aimed towards climate change mitigation, the commitment or “wilful individuals” and knowledge of officials at a management level have ensured the success of such actions.

The questionnaires and interviews revealed that, as much as there is funding from both internal and external sources, the capacity in terms of the implementation of climate change mitigation programmes/projects is still lacking resulting in the programme/project not being fully supported and effectively implemented, a constraint highlighted by schools as well.

The 8 City participants confirmed that, in most cases, when a project does not have human resources to ensure implementation, funds would normally be taken away and used up for a different project for which financial resources were not initially allocated. However, Bulkeley and Newell (2010) warns that not tackling climate change will ultimately compromise a shift to a low carbon economy, which governments should be striving for so as to enhance significant business opportunities which could otherwise not have realised. As stated by a participant responsible for Sustainable Energy and Climate Change that:

“Most of the funding initially allocated to my projects was redirected due to the lack of human capacity to monitor their implementation, and still the City has not yet appointed people to manage these projects.”

The 6 other City participants also indicated that funds intended for projects aimed at water efficiency and tree planting were diverted to a housing project, viewed as a competing priority. The decision makers felt housing people took priority at that point in time, compromising on the intended projects that would have benefited the environment. The lack of capacity (know-how) was another major finding as one of the participants from Energy and Electricity stated:

“It is incredibly difficult to get the cooperation of our Roads and Stormwater colleagues when retrofitting of traffic lights has to be done. Just because they don’t have faith and how the solar energy system works, they think retrofitting will just waste money and create a lot of work for them in terms of traffic management.”

Bulkeley et al (2009) makes reference to a study conducted by Holgate (2007) on climate change policy and action in Johannesburg and Cape Town, which indicated that human resources dedicated towards responding to the effects of climate change would normally be responsible for other environmental challenges as well, resulting responses to climate change being minimal.

The 27 participating schools highlighted the importance of educating learners on the impacts of climate change at an early age so as to ensure a change of mindset while learners are still young. Most participants still view climate change as a mysterious phenomenon, and demystifying it by simplifying how it is described and explained to primary school learners and the general public will improve their understanding.

The 20 school participants indicated that support in terms of initiatives other than those in the curricula was lacking from the Department of Education. The 3 school participants indicated that the Department of Education has refused them to participate in an initiative by the Department of Environmental Affairs which aimed at raising environmental awareness on the importance of wetlands. The one school stated:

“The Department doesn’t see how caring for wetlands is part of what we need to learn. They fail to make linkages between our actions and the impact they have on the environment which will eventually increase our knowledge changing our perceptions.”

Other 3 schools indicated that the national and provincial departments of environmental affairs still needs to put more effort in raising environmental awareness by communicating the subject in a manner understood by any person. They suggested that this can be done by communicating the message in different indigenous languages as well as linking messages to the daily activities for people to be able to relate, and stated, “for example, tell people to plant more trees rather than cutting them to help with the shade and cooling during the summer months.”

The 16 schools indicated financial resources barely exist. For example one school commented: “How can the Department of Education contribute financially to our environmental programs and projects when they think their mandate is to educate and not to protect the environment, they just do not have the bigger picture.”

The above statement is a clear indication of the lack of cooperative governance. It also suggests that national, provincial and the local spheres of government still do not view themselves as one government with differentiated responsibilities. Each sphere still views itself in isolation without the involvement of the other

Figure 4.3 below depicts the bias by the City on the high number of energy efficiency projects implemented, which may be viewed as, energy saving being a priority for the City and hence an investment in projects that seek to achieve this objective.

#### *4.2.2 Proposed initiatives for climate change mitigation*

Figure 4.3 below indicates the number of projects implement by both the City and Schools within the different thematic areas. This figure suggests that energy efficiency is more important to both the City and schools in terms of mitigating the effects of climate change. However schools also invested more into waste minimisation followed by water efficiency projects. It is

evident from the majority number of projects implemented by the City falling within the energy efficiency thematic area as indicated in Figure 4.3 below, that the City want to reduce emissions resulting from the generation of electricity.

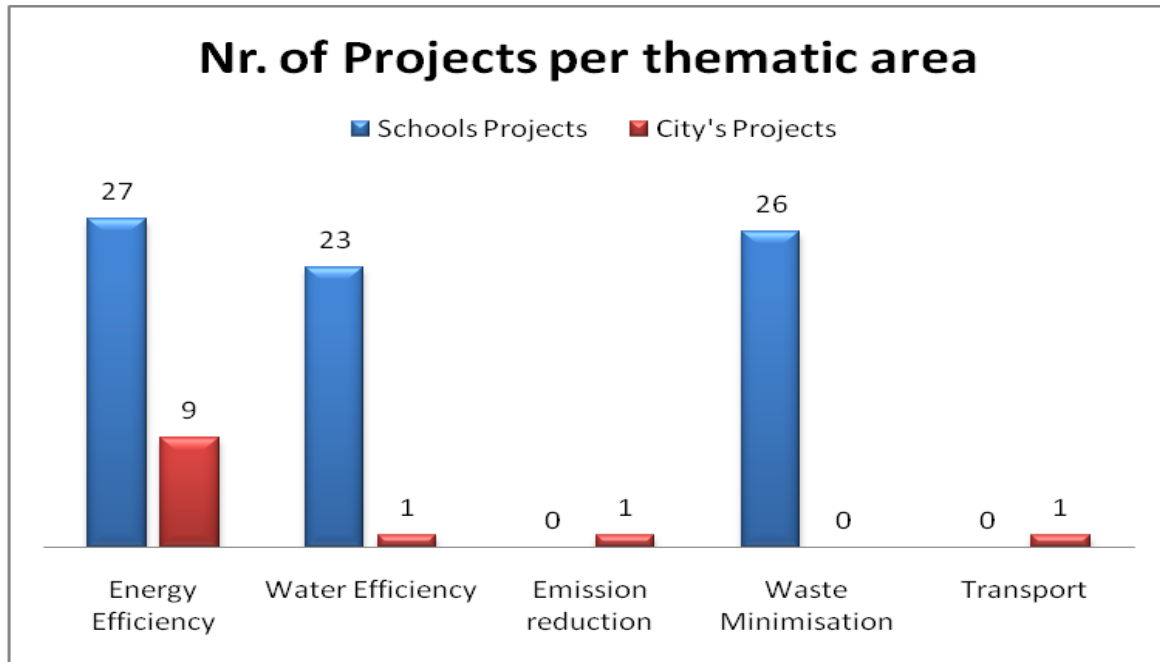


Figure 4.3: Number of projects per thematic area: City and Schools

Most City divisions that participated in the study such as, Energy and Electricity, Roads and Stormwater, Sustainable Energy and Climate Change as well as Air Quality; proposed that if the City wants to significantly contribute towards the reduction of greenhouse gases, it has to prioritise specific projects within the following thematic areas, energy efficiency, non-motorised transport, efficient public transport infrastructure as well waste minimisation.

However the Transport division is adamant that the City should rather prioritise non-motorised transport and improve its public transport infrastructure and stated “...vehicles contribute a lot to the amount of greenhouse gases in the atmosphere and more so to carbon monoxide....”

The Waste Management division of the City regards initiatives striving towards waste minimisation as the future of the City and stated “The City could generate revenue out of the methane gas in landfill sites while minimising the amount of waste disposed of, through

separation at source and by building a competitive market [pay more for waste] for waste exchange so as to promote reuse and recycling”.

The schools participants indicated their interest would be in waste minimisation programmes and all schools were in agreement that a clean environment is what communities they live in needs. They indicated that when communities realise how clean the environment they live in is, they tend to find other means to keep it clean and find ways of reducing the amount of waste generated. Seventeen schools indicated composting out of wet waste and using the compost to start vegetable gardens within the school premises as a desirable programme. One school commented “Vegetable gardens can be started with the aim of using compost made out of wet waste and watered with rain water collected from the Jojo tanks”.

However, all twenty-seven schools were implementing projects within the energy efficiency thematic area as depicted on Figure 4.5 below, while twenty-three initiated water efficiency projects and twenty-six implemented waste minimisation projects. Twenty-seven schools that implemented energy efficiency projects indicate that it was easy to save energy especially with the provision of energy efficient light bulbs they were able to obtain from the Electricity Division of the City.

The one school proudly indicated “With the amount of energy saved, we are sure we have greatly reduced the pollutants emitted into the air when generating electricity.”

When a question was posed that they propose projects that will seek to mitigate the impacts of climate change, all twenty-seven schools prioritised waste minimisation, water efficiency and energy efficiency. Three schools out of the twenty-seven also commented “greening” through tree planting should also be prioritised. Winkler (2010) also agrees that the greening of cities including tree planting is crucial and this may enhance positive social behaviour and have ancillary benefits, producing win-win situations.

### 4.2.3 Emerging Patterns

Analysing the percentage of projects implemented per thematic area by both the City and schools, seventy-five percent of projects implemented seem to have been within the energy efficiency thematic area for the City while thirty-six percent of projects implemented by schools are within the energy efficiency thematic area followed by thirty-four percent within the waste minimisation thematic area and water efficiency comprising the remaining thirty percent, see Figure 4.4 and 4.5 below.

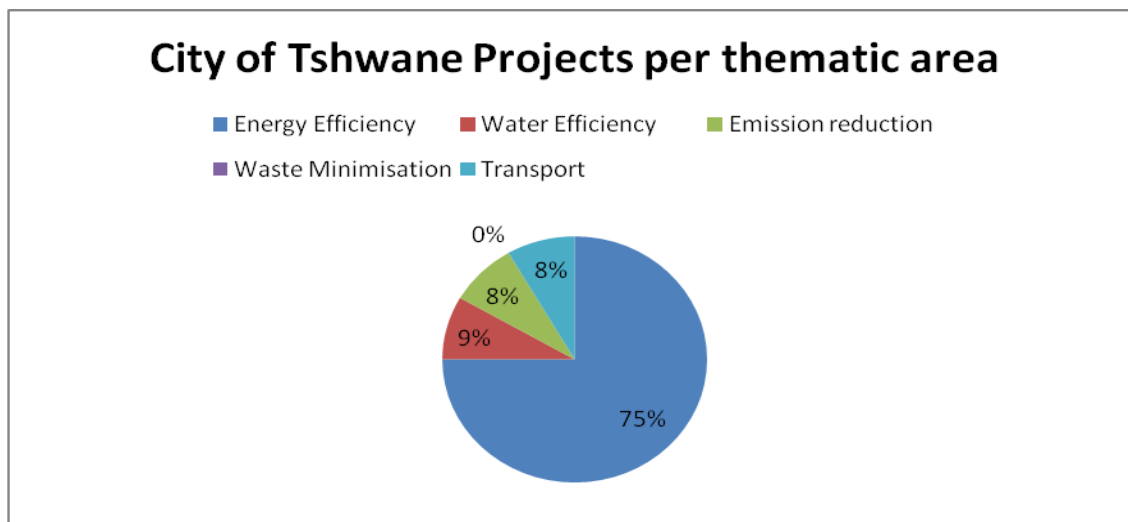


Figure 4.4: Percentage number of projects per thematic area

Du Plessis et al (2003) suggest that since the reliance of South Africa for electricity generation is on fossil fuels, which is a major contributor to climate change; it is imperative that mitigation efforts focus on renewable energy such as solar energy. The City's focus is on solar energy as an alternative source of energy, this is a finding made from the number of projects within the energy efficiency thematic area which are mostly solar powered.

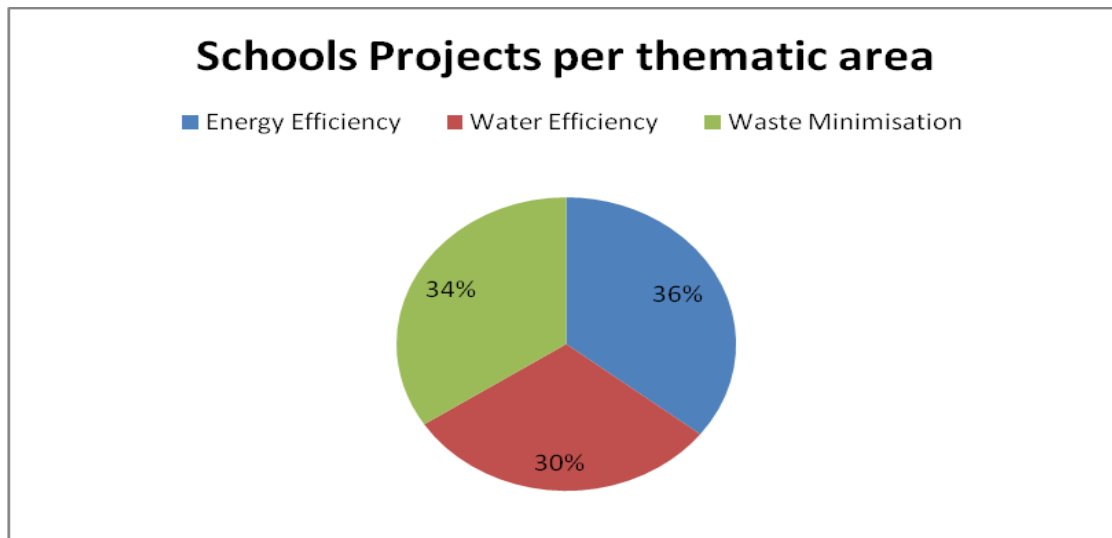


Figure 4.5: Percentage number of projects per thematic area

In terms of the number of projects, as per Figure 4.5 schools may appear to have implemented more projects than the City, however each school had one project or none in some instances for each of the three thematic areas selected. When schools were asked why not more than one project in each thematic area was implemented, a number of challenges were mentioned and the lack of financial resources being one major constraint as it has already been alluded to in section 4.2.1 above.

### 4.3 The Integration of climate change mitigation in City Policies and strategic documents

The study has reviewed four main strategic policy documents developed by the City to establish whether or not climate change mitigation has been incorporated into the City's existing policy documents. The strategic documents reviewed include the Tshwane Integrated Development Plan (IDP), Tshwane Integrated Environmental Policy (TIEP), Tshwane Local Authority Energy Strategy and the Air Quality Management Plan for the City of Tshwane Metropolitan Municipality (AQMP).

A publication by the South African Environmental Observation Network (2011) suggests that environmental change requires periodic review of policies with a bearing on the environment to ensure the alignment of such policies to climate change response measures. This will counteract



the fragmented approach of existing policies and create a balance in the three main sectors of sustainable development which are the economic, environmental and social (Pauw, ed, 2011).

Draper and Mbirimi (2010) also emphasize that it is almost impossible to respond adequately to climate change impacts without policies with a holistic view, anchored in sustainable development.

#### *4.3.1 The Tshwane's Integrated Development Plan (IDP)*

The vision of the Tshwane Integrated Development Plan (IDP) of 2008-2011 is “to establish Tshwane as the leading African Capital City of Excellence that empowers the community to prosper in a safe and healthy environment” while its mission is “to enhance the quality of life of all the people in the City of Tshwane through a developmental system of local government and by rendering efficient, effective and affordable services”. The City’s IDP has five (5) strategic objectives and of relevance to this study are strategic objective 1 and 3 which state:

- Objective 1 - “to provide quality basic services and infrastructure” and includes the provision of services such as energy, water, waste, sanitation, roads, storm water infrastructure and housing.
- Objective 3 - “to fight poverty, build clean, healthy, safe and sustainable communities and includes amongst others, the promotion of viable communities and promotion of environmental sustainability.

The criteria used by the City for the prioritisation of programmes/projects to be included in the IDP does not cover aspects of climate change and as result City’s IDP indicates that very little attention has been given to climate change mitigation and adaptation (CTMM, 2008).

#### *4.3.2 The Tshwane Integrated Environmental Policy (TIEP)*

The Tshwane Integrated Environmental Policy (TIEP) of 2005 is an approved Council Policy with a vision that state “to be an internationally acclaimed African capital city of excellence that

empowers the community to prosper in a safe and healthy environment”. The Policy has objectives it seeks to achieve categorised into the broader strategic areas and one of the objectives that addresses greenhouse gas emissions reductions is “to manage air quality in Tshwane in terms of the requirements of the relevant legislation in order to improve it in areas with poor quality and maintain it in areas of good quality by, but not limited to:

- “Determining which current air emissions in Tshwane must be reduced and the extent of the required reduction in consultation with all relevant authorities and stakeholders”.

One of the objectives within the TIEP is to “enable an integrated energy planning approach in planning for and delivering energy services” (CTMM, 2005). The TIEP further states that the objective will be achieved by “...finalising and implementing the Tshwane’s sustainable energy strategy” also referred to as the climate change strategy (CTMM, 2005). The TIEP does not specifically refer to climate change mitigation and/ or adaptation measures.

The Policy does address issues of environmental sustainability, but does not necessarily cover aspects of climate change mitigation and adaptation; it has however, recommended the development and implementation of the Tshwane Local Authority Energy Strategy which will be discussed in sub-section 4.3.3 below. It is recommended that an approach to policies that seek to mitigate greenhouse gas emissions should make the most of natural synergies between climate protection and development priorities, aiming to advance drivers for actions that reduce emissions which would result multiple benefits (Sathaye et al., 2007).

#### *4.3.3 The Tshwane Local Authority Energy Strategy*

The Tshwane Local Authority Energy Strategy of 2006 clearly states that “it has been prepared on the basis of energy issues identified in the detailed State of Energy Report, which provides a baseline for energy use and greenhouse gas emissions evaluation”. The Strategy concludes that, the following sectors industry, construction, household and transport sectors are the significant contributors to greenhouse gas emissions; however, it does outline an action plan of how the City should embark on emissions reduction initiatives.

The main focus is on institutional arrangements and alignment. As for the climate change aspects, there are no proposed actions on how the City would mitigate and adapt to climate change impacts. Winkler (2009) argue that the primary goal of climate policies is the reduction of greenhouse gas emissions as compared to non-climate policies, a phenomenon which might need to be adopted by the City when reviewing its policies and strategies.

#### *4.3.4 The Air Quality Management Plan for the City of Tshwane Metropolitan Municipality*

The Air Quality Management Plan of 2006 states the reduction of greenhouse gases as part of the City's climate change protection programmes (CTMM, 2006). The plan also has identified the different strategies in terms of how it intends to achieve this goal. This plan also identified priority pollutants, sources and affected areas. It also proposed actions by the City in improving the quality of air within the City however these actions are not quantified. This observation has been made with all strategic documents evaluated and hence Parry et al (2001) suggest that cost is one of the factors influencing mitigation. Even so, if it was clear what damages could be avoided and the results thereof, it might be realised the costs for mitigation far outweigh the damages (Parry et al, 2001).

In reviewing the plan, it was also found that as much as the plan recommends a dedicated structure to manage climate change and air quality functions, a dedicated structure for the implementation of policies and strategies that aim to reduce greenhouse gas emissions is still not established (interview with Mr Siphuma, 18 March 2011). Carmin et al (2009) indicated that when environmental issues within the local government are lead by environmental departments, they are often not prioritized as environmental departments tend to be marginalized, and recommends that climate change mitigation should rather be allocated to offices of the Executive Mayor or City Manager as it cuts across all departments within the municipality and this will also ensure political support.

#### 4.4 Perceptions on the City's response to climate change mitigation

The City may be implementing projects contributing towards climate change mitigation; however only a total of twelve (12) projects, as depicted on Figure 4.6 below, aim at climate change mitigation. It is recommended by Parry et al (2001) that mitigation alone is not sufficient; it can delay climate change impacts but needs to be combined with adaptation which will increase the resilience against climate change impacts as the two mechanisms are meant to complement each other. None of the projects implemented by the City focuses on adaptation, however Boto et al. (2007) suggest that there's a lack of comprehensive and comparable studies within regions, which focus on future options and pathways for adaptation making it difficult for cities to identify areas in need for adaptation.

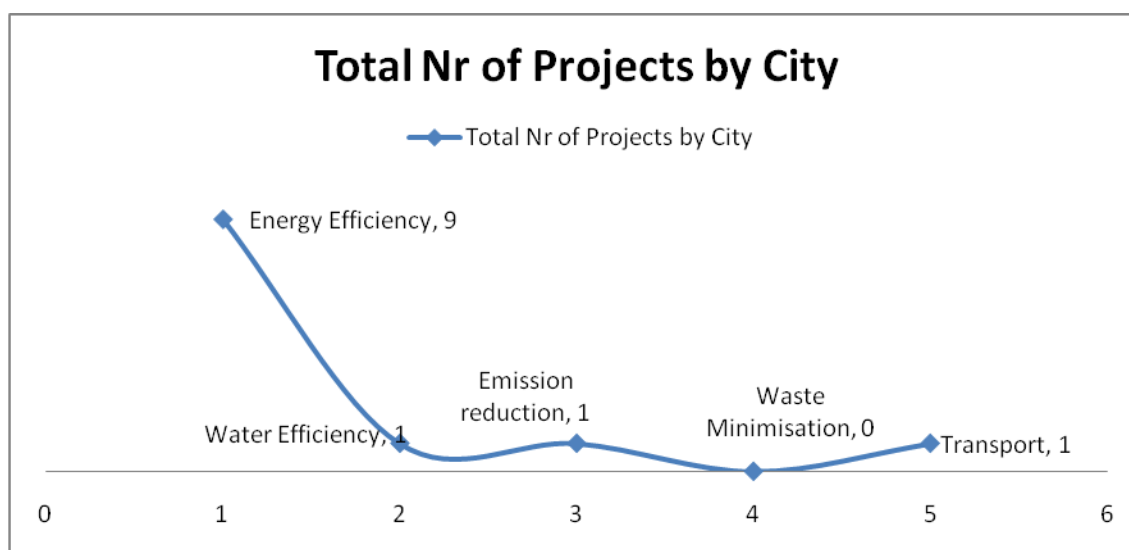


Figure 4.6: Total Number of climate change mitigation projects by City

There is therefore a need for intensive awareness campaigning on climate change impacts, as climate change mitigation and adaptation is still viewed as another sphere of government's responsibility rather than that of the whole government with differentiated responsibilities. A study conducted by Meadows (2006) indicates that, the rural and the urban poor communities are the most vulnerable to climate change impacts and hence mitigation efforts including education should be directed where needed most. Winkler (2010) also stated "changes in social behaviour,

whether driven by policy, education, or awareness, may yet prove to have large-scale and low cost mitigation effects.”

## **5. RECOMMENDATIONS AND CONCLUSION**

In conclusion, the City of Tshwane as a local sphere of government’s focus is more on the provision of basic services as mandated rather than the provision of these basic services in consideration of environmental and climate change impacts resulting from the city’s activities and operations.

The City’s policies and strategies currently in place will need to be reviewed to incorporate climate change aspects and require commitment by management and the political structures to ensure accountability. In light of the above, the alignment of air quality plans and climate change strategies and action plans is imperative including the integration of these two aspects in the City’s strategic documents and policies.

It is also recommended that programmes and projects aimed at the reduction of greenhouse gas emissions must be interdepartmentally coordinated so as to enable the City to benefit from Cleaner Development Mechanisms credits and realise the benefits derived from mitigation measures. Held et al (2011) also indicated that dealing with climate change require commitment to cut significantly on emissions. This change refers to, cutting down on electricity consumption and moving from polluting fossil fuels to cleaner fuels. However, it is further elaborated that low carbon policies require acceptance by society and leadership by government and this refers to all spheres of government including the City as a local sphere (Held et al, 2011).

The study revealed that a carbon footprint study for the City must be undertaken so as to measure the impact of the City in terms of carbon emissions; without this study, the City is not able to determine where it impacts the most as well as to focus its resources and efforts where there is a greater need with greater benefits. This study will also assist with the coordination of reduction of greenhouse gas emissions from a policy level and mechanisms could then be put in place to monitor and evaluate achievements.

The allocation of both human and financial resources is imperative in the implementation of climate change mitigation efforts. This is a concern that stood out from the participants' views, that is both financial and human resources, as it has resulted in the failure of programmes and projects that sometimes do not need financial resources from internal sources but rather mobilisation and internal coordination

Since the Tshwane Local Authority Energy Strategy was never implemented due to lack of allocation of resources, it must be reviewed to include climate change mitigation and adaptation measures; and resources be allocated to ensure effective implementation.

Education and awareness raising initiatives are also poorly coordinated due to lack of resources. While education and awareness raising initiatives are crucial in mitigating for climate change, they are to be intensified with dedicated resources with the focus on vulnerable communities within the City. It is in the view of Draper and Mbirimi (2010) that knowledge management is key, awareness raising pertaining to climate change issues is imperative and ensuring that climate change information is "...made available in a usable form..." is an urgent matter.

Currently there are a number of awareness raising campaigns on climate change which are intensified during days of environmental importance such as, World Environment Day, Ozone Layer Protection Day, 60 minutes of energy saving initiative and others. However, departments as well as the community still do not have an understanding of the role they are suppose to play. This might have resulted from the fact that awareness raising initiatives are only intensified during these important days rather than integrated into the City's daily operations.

Considering that the allocation of resources, that is, financial and human resources is a major concern, Oketh-Ogendo and Ojwang (1995) suggest that capacity building and capacity utilisation are also crucial and imply "the ability to train and mobilise scientific and management expertise on climate change issues; to establish, organise and operate basic development data especially on energy production, distribution and consumption; to take stock of natural and

managed resources; and to undertake accurate projections of response options to different scenarios”.

Tree planting has been indicated by schools as one of the projects the City should consider investing in, to ensure the reduction of greenhouse gas emissions (GHGs). Openshaw (2005) indicated that for any project to be sustainable, there need to be participative planning. He specifically referred to projects that seek to enhance the protection of local forests. When communities are involved in any type of project including tree planting, they tend to protect these natural assets rather than cutting them down as there is an element of ownership already instilled in them (Openshaw, 2005). This makes community involvement at all levels more crucial.

Another climate change mitigation effort is to ‘decarbonise transportation’ so as to improve existing transportation infrastructure (Rowlands, 2005). Non-motorised transport is one of the projects the City has implemented but only at a smaller scale and with the effect of emissions from the transport sector; the City may have to consider intensifying the construction of bicycle and walking lanes. It is also recommended by Crawford and French (2008) that low carbon urban development should promote cycling and walking while reducing the number of cars on roads.

## 6. REFERENCES

- Adger, W. N., Lorenzoni, I. & O'Brien, K.L. (Eds) (2009). *Adapting to Climate Change: Thresholds, Values, Governance*. Cambridge University Press.
- Archer, D. & Rahmstorf (2010). *The Climate Crisis: An Introductory Guide to Climate Change*. Cambridge University Press.
- Balnaves, M. & Caputi, P. (2001). *Quantitative: Introduction to Quantitative Research Methods: An investigative approach*. Sage Publications.
- Blignaut, J. & de Wit, M. (2004). *Sustainable Options: Development lessons from applied environmental economics*. UCT Press, Cape Town.
- Boko, M., Niang, I., Nyong, A., Vogel, C, Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. & Yanda, P. (2007). *Africa. Climate Change 2007. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linde, P.J. & Hanson, C.E (eds)]. Cambridge University Press.
- Bulkeley, H., Schoeder, H., Janda, K., Zhao, J., Armstrong, A., Chu, S. Y. & Ghosh, S. (2009). *Cities and Climate Change: The role of Institutions, governance and urban planning*. Report prepared for the World Bank Urban Symposium on Climate Change. Durham University, UK.
- Bulkeley, H. & Newell, P. (2010). *Governing Climate Change*. Routledge Global Institutions.
- Carmin, J., Roberts, D. & Anguelovski, I. (2009). *Planning Climate Resilient Cities: Early Lessons from Early Adapters*. Paper prepared for the World Bank, 5<sup>th</sup> Urban Research Symposium, Cities and Climate Change: Marseille, France.



City of Tshwane Metropolitan Municipality (2006). *Air Quality Management Plan*. CTMM.

City of Tshwane Metropolitan Municipality (2005). *Tshwane Integrated Environmental Policy*. CTMM.

City of Tshwane Metropolitan Municipality (2006). *Tshwane Local Authority Energy Strategy*. CTMM.

City of Tshwane Metropolitan Municipality (2007). *Integrated Development Plan 2006-2011*. CTMM.

Cowie, J. (2007). *Climate Change: Biological and Human Aspects*. Cambridge University Press, New York.

Crawford, J. & French, W. (2008). *A low carbon future: Spatial Planning's role in enhancing technological innovation in the built environment*. *Energy Policy* 36: 4575-4579.

Creswell, J.W. (2003). *Research design. Qualitative, quantitative and mixed methods approaches*. Thousand Oaks, CA: Sage.

Davis, C. (ed) (2011). *Climate Risk and Vulnerability: A Handbook for Southern Africa*. CSIR, South Africa.

Dawson, R.J., Hall, J.W., Barr, S., Batty, M., Bristow, A., Carney, S., Evans, S., Ford, A., Kohler, J., Tight, Walsh, C., (2006). *A blueprint for the integrated assessment of climate change in cities*. Tyndall Centre Working Paper.

De Vos, A.S. (ed), Strydom, H., Fouche & C.B., Delpont, C.S.L. (2002). *Research at Grass Roots: For the social sciences and human service professions*. Second Edition. Van Schaik Publishers, Pretoria.

Draper, P. & Mbirimi, I. (ed) (2010). *Climate Change and Trade: The Challenges for Southern Africa*. Fanele, South Africa.

Du Plessis, C., Irurah, D. K. & Scholes, R. J. (2003). *The built environment and climate change in South Africa*. Building Research and Information 31 (3-4): 240-256.

Fink, A. (2003). *How to Sample in Surveys*. Second Edition. Sage Publications.

Goddard, W. & Melville, S. (2001). *Research Methodology: An Introduction*. Second Edition. Juta, Landsdowne.

Goldie, J., Douglas, B. & Furnass, B. (2005). *In Search of Sustainability*. CSIRO, Australia.

Held, D., Hervey, A. & Theros, M. (eds) (2011). *The Governance of Climate Change: Science, Economics, Politics & Ethics*. Polity Press, UK.

<http://commons.wikimedia.org/wiki/>. *Global Mean Temperatures*. (Accessed: 13 June 2012)

IPCC, (2007). *Climate Change 2007: Synthesis Report: Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland.

<http://www.ipcc.ch/> (Accessed 11 January 2011)

Klein, R.J.T., Huq, S., Denton, F., Downing, T.E., Richels, R.G., Robinson, J.B. & Toth, F.L. (2007). *Inter-relationships between adaptation and mitigation*. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. & Hanson, C.E. (eds)]. Cambridge University Press.

Lomborg, B. (1998). *The Skeptical Environmentalist: Measuring the Real State of the World*. Cambridge University Press.

Mazo, J. (2010). *Climate Conflict: How global warming threatens the security and what to do about it*. USA and Canada, Routledge.

Marshall, C. & Rossman, G. B. (1995). *Designing Qualitative Research*. Second edition. Sage Publications, Thousand Oaks, CA.

Meadows, M. E. (2006). Global Change and Southern Africa. *Geographical Research* 44 (2): 135-145.

Money, D. (1994). *Environmental Issues: The Global Consequences*. British Library.

Moomaw, W.R., Moreira, J.R., Blok, K., Greene, D.L., Gregory, K., Jaszay, T., Kashiwagi, T., Levine, M., MacFarland, M., Siva Prasad, N., Price L., Rogner, H., Sims R., Zhou, F. & Zhou, P. (2001). *Technological and economic potential of greenhouse gas emission reduction*. Climate Change 2001: Mitigation. Contributions of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Metz, B., Davidson, O., Swart, R. & Pan, J. (eds)]. Cambridge University Press.

Oketh-Ogendo, H.W.O. & Ojwang, J.B. (1995). *A Climate for Development: Climate Change Policy Options for Africa*. ACTS Press, Nairobi.

Openshaw, K. (2005). *Climate Change and Africa*. Edited by Low, P.S Cambridge University Press, UK.

Parry, M., Arnell, N., McMichael, T., Nicholls, R., Martens, P., Kovats, S., Livermorea, M., Rosenzweig, C., Iglesias, A. & Fischer, G. (2001). *Millions at risk: defining critical climate change threats and targets*. *Global Environmental Change* 11: 181-183.

Pauw, J. C. (Ed) (2011). *Combat Change with Change: Translating: Observations on Environmental Change in South Africa into Long-Term Policy Considerations for Sustainable Development*. SAEON, Pretoria.

Peters, M., Fudge, S. & Jackson, T. (2010). *Low Carbon Communities: Imaginative Approaches to Combating Climate Change Locally*. Edward Elgar Publishing Limited, UK.

Reisinger, A. (2009). *Climate Change 101: An Educational Resource: Science – Impacts – Adaptation – Mitigation - Decision-Making Challenges*. Institute of Policy Studies and New Zealand Climate Change Research Institute.

Republic of South Africa, (1996). *The Constitution of the Republic of South Africa No. 108 of 1996*. Government Printers, South Africa.

Rowlands, I. H. (2005). *Climate Change and Africa*. Edited by Low, P.S. Cambridge University Press, UK.

Sathaye, J., Najam, A., Cocklin, C., Heller, T., Lecocq, F., Llanes-Regueiro, J., Pan, J., Petschel-Held, G., Rayner, S., Robinson, J., Schaeffer, R., Sokona, Y., Swart, R. & Winkler, H. (2007). *Sustainable Development and Mitigation*. In *Climate Change 2007, 692 - 742: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Metz, B., Davidson, O.R., Bosc, P.R., Dave, R., Meyer, L.A. (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Sutton, P.W. (2007). *The Environment: A Sociological Introduction*. Polity Press, UK.

UNFCCC, (1992). *Convention on Climate Change*. Climate Change Secretariat, Bonn, Germany.

UNFCCC, (1998). *The Kyoto Protocol to the Convention on Climate Change*. Climate Change Secretariat, Bonn, Germany.

Winkler, H. (2009). *Cleaner Energy Cooler Climate: Developing Sustainable Energy Solutions for South Africa*. HSRC Press, South Africa.

Winkler, H. (2010). *Taking Action on Climate Change: Long Term Mitigation Scenarios for South Africa*. UCT Press.

World Resource Institute, (2005). *Aggregate Contributions of Major Green House Gas Emitting Countries*. <http://www.wri.org/chart/aggregate-contributions-major-ghg-emitting-countries-2000>. (Accessed 3 July 2010)

Yin, R. K. (2003). *Case Study Research: Design and Method*. Third edition. Sage Publications.

Yin, R. K. (2012). *Applications of Case Study Research*. Third edition. Sage Publications.

Zietsman, L. (Editor) (2011). *Observations on Environmental Change in South Africa*. Sun Media, Stellenbosch.

## **BACKGROUND READING**

Department of Environmental Affairs and Tourism, (n.d.). *South Africa's Initial National Communication under the United Nations Framework Convention on Climate Change*.

Department of Environmental Affairs and Tourism, (2004). *A National Climate Change Strategy for South Africa*.

International Council for Science, (2008). *Science Plan: Global Environmental Change (including Climate Change and Adaptation) in Sub-Saharan Africa*.

Rayner, S. & Malone, E.L. (1998). *Human Choice and Climate Change: Volume 2: Resources and Technology*. Batelle Press, USA.

Tickell, O. (2008). *Kyoto 2: How to manage the global greenhouse*. Zed Books Ltd, London.

Yamin, F. & Depledge, J. (2004). *The International Climate Change Regime: A guide to rules, institutions and procedures*. Cambridge University Press, UK.