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The potential impacts of climate change on water supply in Johannesburg

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5 BACKGROUND ON SOUTH AFRICA AND JOHANNESBURG

"Climate change is an issue of the utmost seriousness, and its effects will be felt by everyone all over the world"

– Minister of Water Affairs and Forestry (Sonjica, 2005, 1).

South Africa – and particularly Johannesburg – will not escape the impacts of climate change. In fact, South Africa has already begun experiencing the consequences of a change in climate due to global warming. As revealed in Chapter three, this developing country has had to deal with the reality and burden of balancing development, with the environmental problem of climate change. Chapter five provides an outline and context of South Africa and the city of Johannesburg, in terms of the physical and climate change factors impacting on this region. This chapter provides background knowledge to the following chapter, in projecting the potential impacts that Johannesburg will be facing. Firstly, overall concise context, description and planning features of South Africa and Johannesburg are introduced. Secondly, a picture is painted of South African and Johannesburg's water supply. Thirdly, the history, understanding and acknowledgement of climate change in South Africa – and predominantly in Johannesburg – is presented. Fourthly, the existing climate change impacts encountered in South Africa are highlighted. Lastly, a conclusion to this chapter is provided, in addition to clarifying why the specific international and African research in Chapter four is relevant to the city of Johannesburg. The basis for this chapter is to offer information, which applies, to the entire South Africa, and then subsequently narrowing that down to the province of Gauteng and to Johannesburg in particular.

5.1 CONTEXT AND PLANNING

South Africa is mostly a semi-arid country, with a desert and semi-desert climate in the west and a sub-humid climate along the east coast (see Figure A3 in Appendix A). The South African mean rainfall of 450 mm per year is beneath the world standard of 860 mm per year, and evaporation is relatively high, therefore, compared to other countries' in the world, South Africa's water resources are exceptionally restricted and limited. This is also partly due to the fact that the country is not home to many large rivers – in fact, its total river flow is small, compared to other rivers in Africa. Groundwater is significant in that it is the main source of water in the rural areas. However, only approximately 20% of groundwater can be utilised (DWAF, 2004).

In South Africa, several densely populated rural settlements and numerous industrial and urban developments originated in isolated areas that were located a long way from constant and sufficient sources of water (DEAT, date unknown; Mukheibir and Sparks, 2003).

The province of Gauteng (See Figure A4, A6, A7 & A8 in Appendix A) has a population of 10.5 million people (2008 estimates). There is constant migration into and out of the province. In Gauteng, greenhouse gas emissions are made up of industry and motor vehicle emissions, and emissions from burning coal. The greenhouse gases appear to be worse in winter, because the pollution is trapped by the steep inversion in temperature. Countless natural water systems in Gauteng have been permanently degraded through mining and construction. The bulk of the water intended for Gauteng is extracted from half the capacity of the Vaal River (See Figure A5, A6 & A9 in Appendix A). Guaranteeing Gauteng's water supply for the future is a significant concern to the province (UN-Habitat, 2008).

The city of Johannesburg (See Figure A7 in Appendix A) has a population of 3.2 million people (2001), residing in both formal and informal residential patterns. Informal settlements are mainly located on the periphery and in marginalised areas. Rapid urbanisation and migration into Johannesburg has occurred due to

various factors, but over the past couple of years commercial and residential development has been the dominant factor. This rapid human settlement has curtailed conservation efforts, and placed the city's natural ridges and open spaces under stress from development. Nowadays, the majority of open spaces are found on the periphery of the city (City of Johannesburg, 2008b).

Environmental concerns and the lack of open spaces are caused by urban sprawl, population growth, urbanisation, the unsustainable misuse of resources and a lack of enforcement when it comes to anti-pollution guidelines. These factors place increased pressure on, exhaust and abuse existing resources and lead to poor water quality. Due to massive human development, water-related infrastructure, sewerage, Stormwater facilities and power supplies have come under increasing strain (City of Johannesburg, 2008b).

"Johannesburg straddles the main watershed divide for the subcontinent and is one of the few cities of its size and kind in the world, which is not situated on a major watercourse" (DWAF, 1999, 1). (See Figure A5 & A8 in Appendix A).

5.2 A DESCRIPTION OF WATER SUPPLY IN SOUTH AFRICA

South Africa is a water-scarce country, with water sources being in limited supply. Across the country, the availability of water is restricted and its distribution unequal because evaporation levels are higher than rainfall, there is inconsistent surface runoff, irregular spatial coverage of rainfall, which is unpredictable and unseasonal (Bridgman, 1998; DWAF, 2004). "Summer, across the majority of southern Africa, is the dominant rainfall season" (Bridgman, 1998, 274). South Africa is also known to be susceptible to droughts and flooding (DWAF, 2004).

South Africa has four major river basins: the Orange River, Maputo River, Limpopo River and the Incomati River. These are international river basins, which means they are shared with neighbouring countries'. These aforementioned

rivers supply about 40% of the entire surface runoff (Hirji et al., 2002; DWAF, 2004).

The local irrigation sector is the main consumer of water, but water is also required for domestic and urban use, power generation, mining, industries and forest plantations (DWAF, 2004). Surface water is the main source of water in South Africa; being mainly used for industrial, urban and irrigation needs (DWAF, 2004; DEAT, 2007b). Groundwater is primarily used in rural areas (DEAT, 2007b). As South Africa develops and grows, the demand for water may soon exceed the supply (Du Plessis et al., 2003).

Numerous industrial developments and settlements in South Africa are “not in line with water availability” and Gauteng province is one such region, which is located in an area with restricted water availability (Du Plessis et al., 2003, 242). Gauteng province receives the bulk of its water from the Vaal River System, which ought to be able to provide the province with the necessary water until about 2025 (see Figure A6 & A9 in Appendix A). As expansion and development continue in Johannesburg, additional water transfers may be required into the Vaal area towards the end of 2025, or if the Vaal River System experiences a shortage before about 2025 (DWAF, 2004).

Johannesburg pipes water from the Vaal River System, which supplies the entire Gauteng province. In addition, Johannesburg has two principal catchment areas: the Jukskei River catchment and the Upper Klip River catchment. The Jukskei River catchment is situated to the north of Johannesburg, and its water supply is mainly used for industrial and agricultural purposes. The Upper Klip River catchment is located to the south, and its water is intended for industrial, domestic, agricultural, recreational and natural environmental uses. In the greater Johannesburg area, water is an important yet limited resource. Although the quality of drinking water in the city is very high, the main problems related to its water are the impacts of pollution, and increased demands being made on water resources (DEAT, date unknown). (See Figure A5, A6 & A8 in Appendix A).

5.3 CLIMATE CHANGE IN SOUTH AFRICA

SOUTH AFRICA

In August 1997, the government of South Africa approved and accepted the United Nations Framework Convention on Climate Change (UNFCCC). The goal of the UNFCCC was to stabilise the atmospheric levels of greenhouse gases. The Kyoto Protocol was formulated in 1997 – since the obligations of the UNFCCC were insufficient to stabilise the levels, Kyoto was established in an attempt to meet the main goal. South Africa became a signatory to this protocol in July 2002 (DEAT, 2004).

"Climate change is a relatively new issue in South Africa due to the prior isolation of this country from international events" (DEAT, 2004, 5). The government departments that are directly engaged with the issue of climate change and its possible impacts have proven to be the most informed. Other departments have a somewhat limited understanding on this issue, and therefore many unconcerned departmental officials (in all fields of government) do not view climate change as an imperative and compulsory issue, but often perceive it as a hindrance to development. Furthermore, in South Africa the mandatory standards of training, education and public awareness on the issue of climate change lag behind (DEAT, 2004).

"By and large, the implications of climate change have not yet been fully and explicitly considered in current water policy and decision-making frameworks" (Schulze, 2005b, 4). However, in 2008, the Minister of Environmental Affairs and Tourism, Marthinus van Schalkwyk, stated that "a progressive policy on climate change had been agreed upon by Cabinet that would help ensure that the country was helping prevent global temperatures from rising a further two percent" (Benton, 2008, 1).

In southern Africa, South Africa is the foremost contributor of carbon emissions, as identified by Rowlands (1998). South Africa contributes 41.9% of the entire emissions produced in Africa, and South Africa is "one of the top 20 greenhouse gas-emitting countries" (Du Plessis et al., 2003, 244). In 2002, the total global

greenhouse gas emissions that South Africa pumped into the atmosphere amounted to about 2% of the world's total output (Du Plessis et al., 2003; Brunner et al., 2005).

JOHANNESBURG

Johannesburg has taken the initiative in acknowledging and curbing the impacts of climate change. The city has entered into a partnership with the International Organisation of ICLEI - Local Governments for Sustainability (also known as ICLEI, originally named - International Council for Local Environmental Initiatives). This organisation has been helping local governments since 1992 with sustainability issues. One of the ICLEI campaigns conducted in South Africa was the Cities for Climate Protection (CCP). The donor-funded CCP operation was implemented in Johannesburg, to help reduce the city's global warming and air pollution emissions by helping it to set up phased quantifiable reduction objectives (SACN, 2007a).

"Johannesburg prides itself in being a world-class city that will unashamedly look at best practices elsewhere and adapting them to local Johannesburg conditions" – Johannesburg Mayor, Amos Masondo (SACN, 2007a, 44).

The City of Johannesburg has also been chosen by the former US President Bill Clinton's Foundation (known as the Clinton Climate Initiative [CCI]) to 'go green'. Johannesburg is one of 40 cities globally to be chosen, and the only one in South Africa, in an initiative to cut greenhouse gas emissions. The foundation provides low-interest loans to establish devices that are energy saving (SACN, 2007a).

The CCI was established in 2006. Its first major venture is operating with the C40 Large Cities Climate Leadership Group. Johannesburg is one of the 15 biggest global cities of this group, which is endeavouring to embark on climate change. Amongst others, these cities allow their municipal buildings to be fitted with energy retrofits in a pilot project aimed at reducing energy use (SACN, 2007a; SACN, 2007b).

The City of Johannesburg, in order to adjust to the impacts of climate change and reduce greenhouse gas emissions, has developed the Johannesburg Climate Change Strategy and Action Plan (City of Johannesburg, 2008a; City of Johannesburg, 2008c). This plan provides mitigation and strategy processes to counteract climate change (City of Johannesburg, 2008c). This strategy and action plan, which was produced in 2008, is currently being updated (McNamara, 2009).

The city of Johannesburg has carried out a vulnerability assessment study, the draft of which, produced in 2008, is currently being updated (McNamara, 2009). Johannesburg embarked on this study in order to improve its capacity to resist and make adjustments for any possible impacts related to climate change (City of Johannesburg, 2008a). The study concentrates on evidence of climate change in Johannesburg, identifies vulnerable areas and their possible impacts and mitigations, and provides overall possible future alternatives for the city, in dealing with climate change (Golder Associates Africa, 2008).

The findings of this vulnerability assessment study will be used to inform Johannesburg's adaptation plans in respect of climate change (City of Johannesburg, 2008a). The plan, which is aimed at adapting to climate change impacts (City of Johannesburg, date unknown a) is scheduled for completion by the end of the year (2009) (McNamara, 2009).

Johannesburg has also established a department (Environmental Management Department) to handle environmental issues and tackle projects to reduce the impact of climate change and enhance the environment (SACN, 2007a). The Johannesburg mitigation programmes include:

1. Solar water heaters in Cosmo City;
2. Solar street lights in Zandspruit;
3. A Bus Rapid Transit system;
4. In the Environmental Management Department, a climate change programme;
5. Electricity-saving measures in five city-owned buildings;
6. A possible landfill gas project;

7. Water-related projects include:
    a. Infrastructure upgrading;
    b. Storm-water maintenance and management plans;
    c. The improvement of and management plans for catchment areas;
    d. Education and public awareness campaigns;
    e. Focus on flood-prone areas and revision of flood lines

    (City Of Johannesburg, date unknown b; SACN, 2007a).

One of the projects that has been implemented in Johannesburg, as regards water supply, is Operation Gcin'amanzi in Soweto. This water-saving project, an initiative of Johannesburg Water, came into being in 2001 (pilot project in 2003) and was set to continue for five years (in 2008 – has been halted due to legal action). The goal is to upgrade Soweto's water reticulation network and provide inexpensive and dependable services to every home. In addition, this project will reduce water loss by slowing water wastage by 15% by the year 2011. Water loss in Johannesburg has mainly occurred due to old underground infrastructure, with bursting and leaking pipes (SACN, 2007a; SACN, 2007b).

5.4 EXISTING CLIMATE CHANGES IN SOUTH AFRICA

Specific existing changes in climate are mainly attributed to existing phenomena, since not many studies have been done on the existing climate change impacts on South Africa, or especially on the city of Johannesburg.

"South Africa is already warming up" (Joubert, 2008, 153). Between 1960 and 2003, both minimum and maximum temperatures in the country have shown a slight increase (Boko et al., 2007; Benhin, 2008; Joubert, 2008). Although the maximum temperatures have increased at a slower rate than minimum temperatures (Boko et al., 2007), "decadal warming rates of 0.1 to 0.3°C in South Africa" have occurred (Boko et al., 2007, 436). In addition, there have been more warm days and fewer cooler days (Benhin, 2008; Joubert, 2008).

Between 1960 and 2003, the seasons experienced varying increases, per decade, in temperature (Benhin, 2008):

1. Summer (December–February) – increase by 0.12°C;
2. Autumn (March–May) – increase by 0.21°C;
3. Winter (June–August) – increase by 0.13°C; and
4. Spring (September–November) – increase by 0.08°C.

In South Africa, recent decades have seen increases in the occurrence of the strongest daily rainfall. On the other hand, the total annual precipitation has shown minor long-term trends (Doherty et al., 2005). The primary precipitation changes occur in winter, although in the eastern areas of South Africa an increase in late summer rainfall has occurred, accompanied by a decrease in early summer rainfall (Boko et al., 2007). In Johannesburg the "water consumption has more than doubled over the past thirty years" (Warburton and Schulze, 2005, 258).

In review, South Africa is a semi-arid country with below-average rainfall, high evaporation rates, and limited water resources. Evaporation levels are higher than rainfall, there is unpredictability and seasonal rainfall, and inconsistent runoff. The country is also prone to droughts and flooding. Surface water is the greatest supplier of water for urban and industrial areas and for irrigation, with the irrigation sector being the main consumer of water in South Africa. Groundwater is mainly used in rural areas. Many urban and rural settlements as well as industrial areas are located far from any water sources.

Johannesburg is a growing city, with large numbers of people migrating to it and high rates of urbanisation – all of which has placed great strain on water resources. The increased demand for water in Johannesburg is one of the city's greatest problems. The city lacks sufficient open spaces. Also, Johannesburg is not situated on a main watercourse. Gauteng, and hence the city of Johannesburg, receive its water from the Vaal dam, but the water supply should only be sufficient until about 2025.

Since 1997, government has accepted the reality of climate change in South Africa, but given that this is a relatively new concept. Many government departments and a great segment of the public do not understand or support the issue. Climate change is also slowly being considered in future plans and policies. The existing climate change impacts in South Africa include an increase in warming in both minimum and maximum temperatures, and an increase in the level of daily rainfall.

Johannesburg has taken the initiative in accepting and trying to limit the effect of climate change. The city is working with many international climate change groups to curb and minimise the affect of greenhouse gases. It has also implemented a climate change strategy and action plan, it is undertaking a vulnerability assessment study, and it is in the process of developing adaptation plans. The Environmental Management Department, which has been set up to deal with the issue of climate change, has already initiated several projects and programmes in Johannesburg that include water schemes – especially since water consumption in Johannesburg has doubled in the past thirty years.

The reason why the particular information in Chapter four is used and focused on, is that it relates directly to planning. All the highlighted factors, in one way or another, affect planning. The existing changes and the potential impacts that are presented in Chapter four are appropriate for Johannesburg, as they will be used in the next chapter to formulate envisaged future impacts for the city. The international information provides a clear foundation to and background on worldwide trends and experiences in the area of climate change. Information related particularly to Africa, narrows down and focuses the data to areas similar to those found in South Africa. In the next chapter, the potential international and African impacts are used in formulating potential future climate change impacts on water supply in Johannesburg.

This chapter has shown and introduced the case study for this report, that being the city of Johannesburg. Therefore, as the report focuses on this city, it is necessary to introduce, explain and explore the facts on South Africa, as they relate specifically to Johannesburg. As this report is based on water supply and climate change, it is therefore essential to highlight these pertinent aspects. This

chapter provides the outline and basis for the next chapter, as the fundamental, specific information provided in this chapter gives a better understanding of the situation in South Africa and in Johannesburg in particular. The information from Chapter four is applied to the subsequent chapter, in an attempt to predict the potential impacts that climate change will have on water supply in Johannesburg.