



Review

Understanding the impact of climate change on the dwindling water resources of South Africa, focusing mainly on Olifants River basin: A review



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ABSTRACT

In this paper, consideration has focused mainly on the extent and usefulness of the existing literature available so far on the understanding of the impact of climate change on water resources in Africa, focusing mainly on the Olifants River basin in South Africa. Here, the existing literature on the impact of climate change on the hydrological cycle (particularly the hydrological processes like temperature, precipitation and runoff) has been reviewed. The uncertainties, constraints and limitations in climate change research have been discussed at great length. A detailed discussion has been highlighted on the remaining knowledge gaps in climate change research, especially in Africa. In addition to the research gaps highlighted here, the emphasis on the need of climate change research by African scientists is included as part of lessons learnt. Overall, the importance of conducting further research in climate change, understanding the potential impact of climate change on our lives, and taking actions to effectively meet the adaptation needs of the people, emerge as an important theme in this review.

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1. Introduction

Understanding climate change is vitally important as such changes coupled with climate variability have the potential to exacerbate or multiply existing threats to human security including water, food, health, and economic insecurity, all of which are of particular concern for Africa (Cisneros et al., 2014). Yet, lack of adaptation and mitigation measures, (Schilling et al., 2012; Vermuelen et al., 2008; Ziervogel et al., 2008), clearly shows that climate change issues are not of immediate importance and therefore do not capture a lot of attention from policy makers in Africa. Neither are these issues featuring highly on priority lists of most African Governments. Quite often, most of these policy makers are busy with more pressing issues which are either of immediate needs to their people or themselves. Such issues may include but not limited to: poverty alleviation, service delivery, and political survival. Generally, in Africa, there seems to be a complete disregard or lack of understanding of the impact of climate change on the continent's resources such as water resources. Yet, the report by the Intergovernmental Panel on Climate Change (IPCC, 2014) is unequivocal that African countries are still the most

vulnerable to these changes mainly due to lack of institutional capacity and economic development.

Nowhere else will the impact of climate change be more severe than in the water sector (Yilmaz and Yazicigil, 2011). This study also points out that climate change is likely to alter the hydrological cycle, an observation that is very much supported by (Gleick and Adams, 2000) and (Xu, 2000) as well. Therefore, since the hydrological cycle is the key component in the understanding of the availability of water on the earth's surface, then, changes in the hydrological cycle due to climate change can lead to diverse impacts and risks for Africa. The potential effects of climate change on water resources will affect every sector of any economy, through impacts on health, agriculture, industry, transport, energy supply, fisheries, forestry, and recreation (Olmstead, 2013). In addition, some water resource impacts will occur through changes in the frequency and severity of extreme events in the form of droughts and floods (Kusangaya et al., 2013). For example, over southern Africa an increase in extreme warm indices (hot days, hot nights, hottest days) and a decrease in extreme cold indices (cold days and cold nights) in recent decades is consistent with the general warming trend observed by (New et al., 2006). It is further argued by (Niang et al., 2014) that these enhanced heat wave probabilities are associated with deficient rainfall conditions that tend to occur during El Niño events, a weather phenomenon that is very common in Southern Africa. If

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these observed changes in climate in the last century (IPCC, 2007) persist into the future, (Kusangaya et al., 2013) suggest that the potential impacts on water resources are likely to increase in magnitude, diversity and severity. Given the already large spatial and temporal variability of climatic factors in Southern Africa, these authors also argue that climate change impacts on water resources are, therefore, likely to be more pronounced in the near future than previously foreseen.

Indeed, according to one of the most recent Intergovernmental Panel on Climate Change reports, (Cisneros et al., 2014), water is one of several current and future critical issues facing Africa. Water supplies from rivers, lakes and rainfall are characterized by their unequal natural geographical distribution and accessibility, and unsustainable water use. Climate change has the potential to impose additional pressures on water availability and accessibility in Africa. This is most evident in the (CEMEX UK Operations Ltd, 2004) report which says that by the year 2025, water availability in nine countries in Africa, mainly in eastern and southern Africa (South Africa included), is projected to be less than 1000 m³/person/yr. Twelve African countries would be limited to 1000–1700 m³/person/yr, and the population at risk of water stress could be up to 460 million people. These estimates are based on population growth rates only and do not take into account the variation in water resources due to climate change. Otherwise, the picture is even gloomier. In addition, one estimate shows the proportion of the African population at risk of water stress and scarcity increasing from 47% in 2000 to 65% in 2025 (Ashton, 2002). The IPCC report (IPCC, 2008) in a way does agree with these findings and goes on to warn that, in fact, this could generate conflicts over water, particularly in arid and semiarid regions. Unfortunately, this argument is very much supported by scholars such as (Faramarzi et al., 2012). The IPCC report (IPCC, 2008) also singles out a specific study that was done in South Africa (Western Cape) where it shows that water supply capacity decreasing either as precipitation decreases or as potential evaporation increases. This projects a water supply reduction of 0.32%/yr by 2020, while climate change associated with global warming is projected to raise water demand by 0.6%/yr in the Western Cape Metropolitan Region (New, 2002).

With all these arguments, it is of no doubt that there is now an overwhelming consensus in the scientific community that climate change is indeed a real phenomenon and need to be understood further. It can be attributed at least in part to anthropogenic climate change such as increased emissions of greenhouse gases from human activities as argued by (CEMEX UK Operations Ltd, 2004).

In case of South Africa and indeed the Olifants River catchment, a climate change impact assessment study for the Olifants River basin has recently been carried out by (Cullis et al., 2010) using synthetically generated climate data. Owing to high variability in downscaled precipitation projections, (Cullis et al., 2010) created synthetic time series of precipitation and temperature for three possible future climate change scenarios (wet, intermediate and dry) by perturbing the historic climate at the monthly time step. In this study, they predicted changes in seasonality of runoff. Using the Regional Climate Models (RCMs), they found that on average, the raw precipitation output from these climate models project generally drier conditions for Southern Africa in the future. In this study, (Cullis et al., 2010) also found out that for two future scenarios (2025 and 2050), the models they used showed drier summers and wetter winters for all synthetic cases.

Considering lack of proper knowledge on climate change studies, this paper intends to highlight the importance of climate change studies especially for South Africa and to create an understanding of the effects of climate change on the already dwindling water resources of the continent. The paper, therefore, reviews and synthesizes literature available so far on the impact of climate change on water resources focusing mainly on the Olifants River basin, as well as identifying and highlighting key research gaps for further research.

The Olifants River basin (Fig. 1) is one of the major river basins in South Africa. Located in the North-eastern part of the country, the Olifants River basin is a principal sub-catchment of the Limpopo River. The basin is home to both small and large scale mining industries in South Africa. In this basin, there are also commercial as well as small holder agricultural farms that use a lot of water for irrigation. In addition to all this, the basin is home to the famous Kruger National Park (KNP). The Olifants River basin is

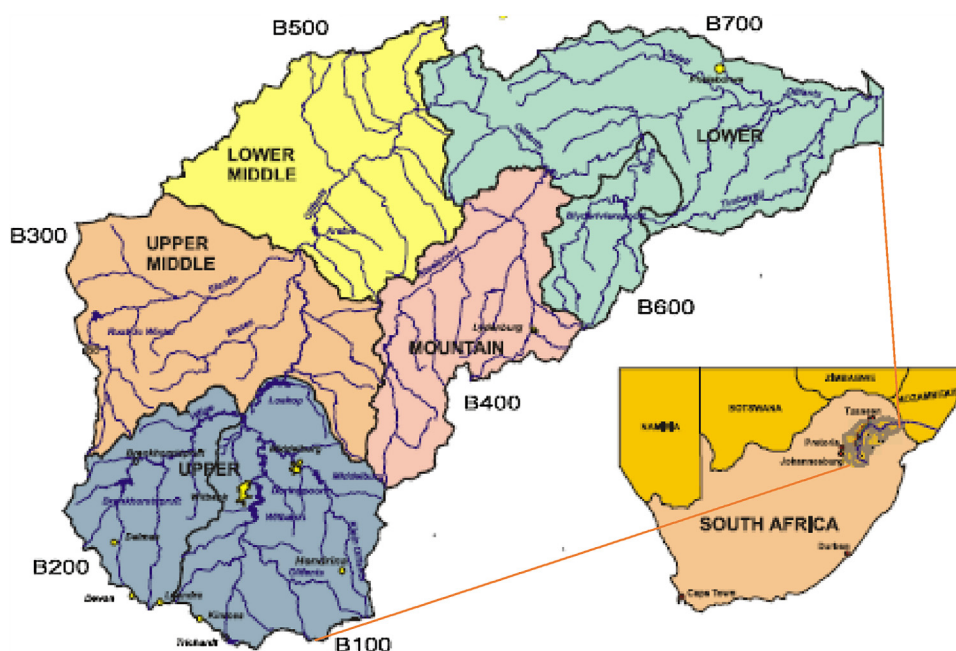


Fig. 1. The Olifants River catchment, <https://www.dwa.gov.za>.

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