WORKING PAPER

Reflecting on the projected impacts of climate change on water security in South Africa and the need to increase the resilience

by
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November 2021

Summary

Climate plays a significant role in the country's economic development. Regular provision of climate information targeting specific sectors enables government and various development actors to improve on decision-making relating to climate change response, risk reduction while encouraging adoption of a resilient approach for tackling the challenges to sustain economic growth, which are influenced by climate. The emphasis is largely on building a climate resilient developmental response over and above management of risks brought on by the changing climate and increased variability.

Water is critical for development, and socio-economic growth. It serves as a key factor for inter-sectoral linkages and forms a basis for development. Therefore, climate change impacts on water resources and development cannot be undermined. While climate change may bring a significant number of negative impacts, planning and addressing those impacts in advance will contribute to making the future sustainable. This paper therefore reminds us of the likely future which our country is facing in terms of the changing climate and emphasises that it is important to continue improving the adaptive capacity for a better resilience.

BACKGROUND

Southern Africa is extremely vulnerable to the impacts of climate change. Climate change poses negative impacts on water resources and development. The projections into the future show declining trends in rainfall because of the changing climate. Increasing temperatures into the future are also projected translating to more drier areas. Evidence shows a record increase in natural disasters and extreme weather events (DEA, 2013, Kephe et al, 2016). Changes in climate and increased variability brings significant implications to production and viability of different sectors. These changes in climate advocates for a balanced planning approach while adapting to the new normal within the context of development. It is important to adequately plan to respond to both droughts and floods while increasing resilience to these extremes. Future infrastructural development needs to increase storage capacity such that more flood water is captured and stored. This can include underground storage where more water may be stored for future use. This will reduce the societal vulnerability to the impacts of floods while reserving a high amount of water for use in drier periods and also for groundwater recharge. On the other hand, recovery from droughts always take longer for the situation to return to near normal. This bears negative implications for economic activities like agriculture as these sectors may take longer than usual to recover after each drought season. While climate change may bring a significant number of negative impacts, planning and addressing those impacts in advance will contribute to making the future bearable (Petja, 2017, WRC, 2018). This working paper therefore brings attention to the state of affairs on climate change and water, with particular emphasis on future water supply and South Africa's strategic water sources.

THE ROLE AND IMPACT OF CLIMATE CHANGE ON WATER

A recent study commissioned by the WRC (Engelbrecht et al., 2020) examined the climate change futures of South Africa with a greater emphasis on the eastern part of the country given the importance of this region to water security. Key areas of interest in this research included South Africa's eastern escarpment, Lesotho and the mega-dam area. Of particular interest are the potential impacts of climate change on the hydroclimate of eastern South Africa, given the impact that such changes may have on water security in the country. This stems from the fact that the Lesotho Highland water schemes and all South Africa's mega-dams are located in eastern South Africa. Moreover, the Gauteng province of South Africa – the economic heartland of the country – has a critical dependence on the Lesotho Highland water schemes for both the quantity and quality of its water supply. The study demonstrated South Africa's vulnerability to multi-year drought in the mega-dam region in the projected future. It was found that multi-year droughts may occur frequently over the mega-dam region as early as the mid-future period of 2046-2065, presumably in response to more frequent occurrence of El Niño events, and with detrimental implications for dam levels. Despite the fact that the region projected to become generally drier, extreme convective rainfall events may occur more frequently over the mega-dam region. Both statistical and dynamic hydrological modelling are show the plausibility of increased streamflow over eastern South Africa. Drastic increases in temperature are likely to lead to increased evaporation in the mega dams and also in drastic reductions in soil moisture. Moreover, climate of the mega-dam region is projected to become more variable in terms of the annual anomalies of both temperature and rainfall.

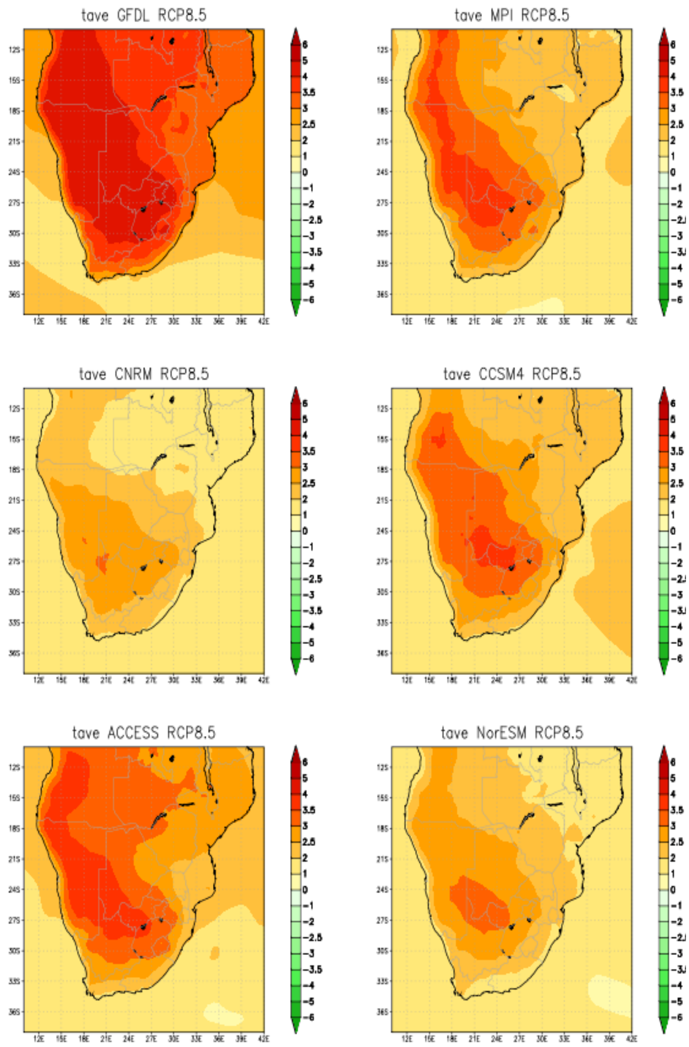

Fig. 1a. CCAM-CABLE projected changes in annual mean temperature (°C) under RCP 8.5 for the period 2046-2065

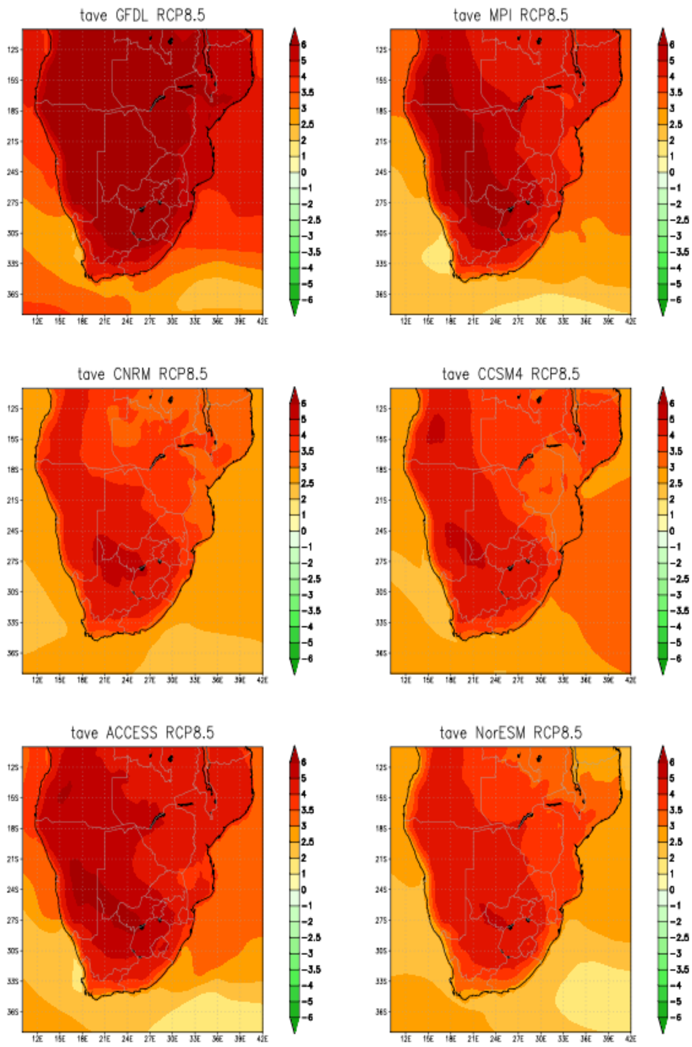

Fig 1b. CCAM-CABLE projected changes in annual mean temperature (°C) under RCP 8.5 for the period

Figures 1a and b show drastic increases in temperature that are projected for South Africa under low mitigation. Rising temperatures are projected to have a range of negative impacts on southern Africa, including reductions in crop yield and livestock production. These may directly impact on water security through inducing enhanced evaporation and land-use change.

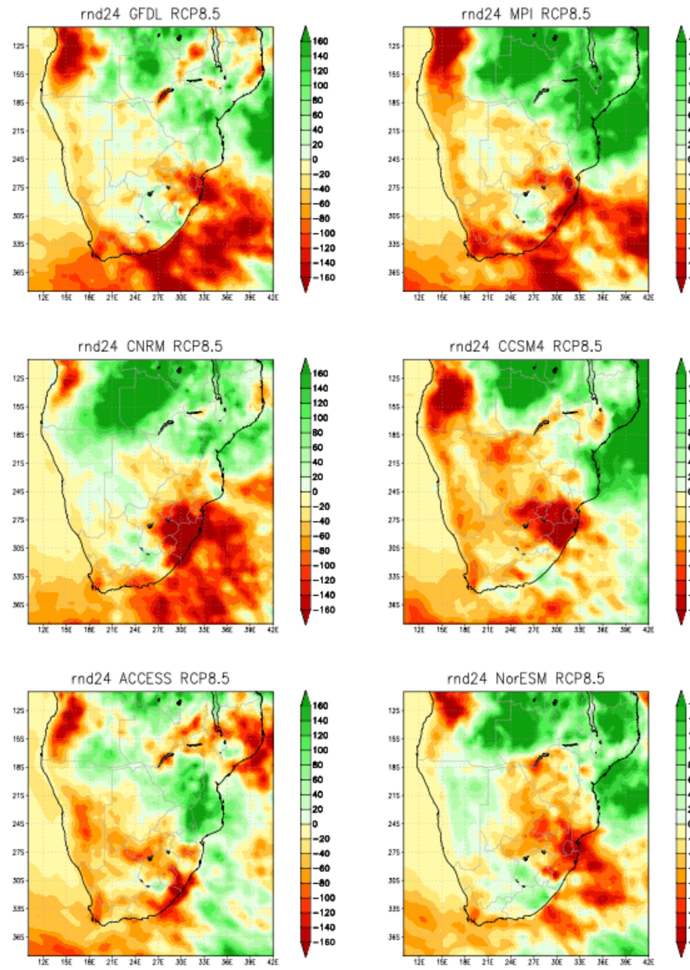

Fig. 2 a CCAM-CABLE projected changes in annual rainfall (mm) under RCP 8.5 for the period 2046-2065 relative to 1961-

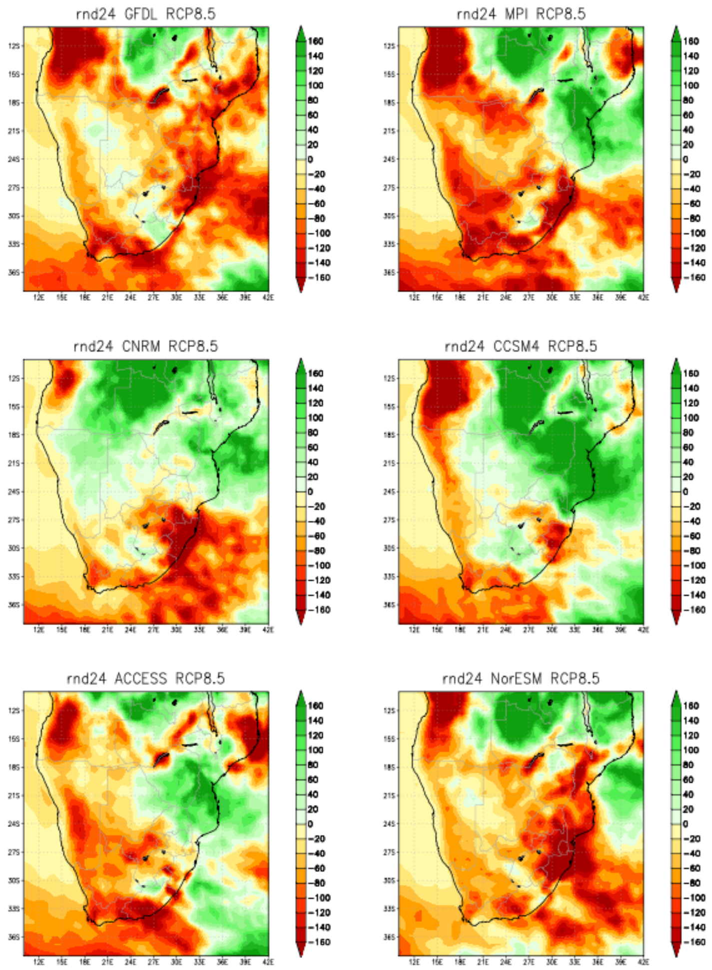

Fig 2 b CCAM-CABLE projected changes in annual rainfall (mm) under RCP 8.5 for the period 2070-2099 relative to

The projections reflected in Figure 2 a and b are indicative of substantial rainfall decreases over the eastern escarpment of South Africa under low mitigation, including Lesotho by the end of the century. Unprecedented dry years may occur as early as the period 2016-2035, and by the mid-future period of 2046-2065 multi-year droughts may be frequently occurring over eastern South Africa. Such changes may seriously compromise South Africa’s water security, including that of Gauteng, and may significantly hamper future industrial development in the country. Further to the north, rainfall increases are projected over much of Mozambique, a signal of change that is likely the result of more landfalling tropical cyclones. Some of the downscalings are indicative of this pattern of change extending southwards into north-eastern South Africa.

IMPLICATIONS FOR SOUTH AFRICA

The southern African region is likely to become generally drier under climate change. Moreover, in its interior the region is warming at about twice the global rate of warming, with further drastic increases in temperature projected to occur under low mitigation futures. The projected general decreases in rainfall over southern Africa are simulated to occur in response to the southward expansion and strengthening of the subtropical high-pressure belt. The more frequent occurrence of mid-level high-pressure systems and associated subsidence under climate change are simulated to suppress convective cloud formation in summer, resulting in general reductions in rainfall over the summer rainfall region.

MITIGATION AND ADAPTATION STRATEGIES

It is acknowledged that climate change is a complex and cross-cutting problem that impacts all sectors (Nhamo et al., 2019a). As a challenge that is affecting all sectors, climate change adaptation needs to be addressed holistically through transformative and circular models that consider the interlinkages of sectors and reduce uncertainties that are associated with linear approaches (Mpandeli et al., 2018). Transformational change is critical when responding to societal changes and when shifting from the norm. There are four climate change thematic areas that need to be addressed to achieve resiliency in the water sector (Iglesias and Garrote, 2015; Mpandeli et al., 2018; Mpandeli et al., 2019), these include (a) integrated policy and institutional frameworks, (b) adoption of water use efficiency technologies, (c) development of an water adaptation strategy, and (d) adoption of transformational and circular approaches to manage water resources (Figure 3).

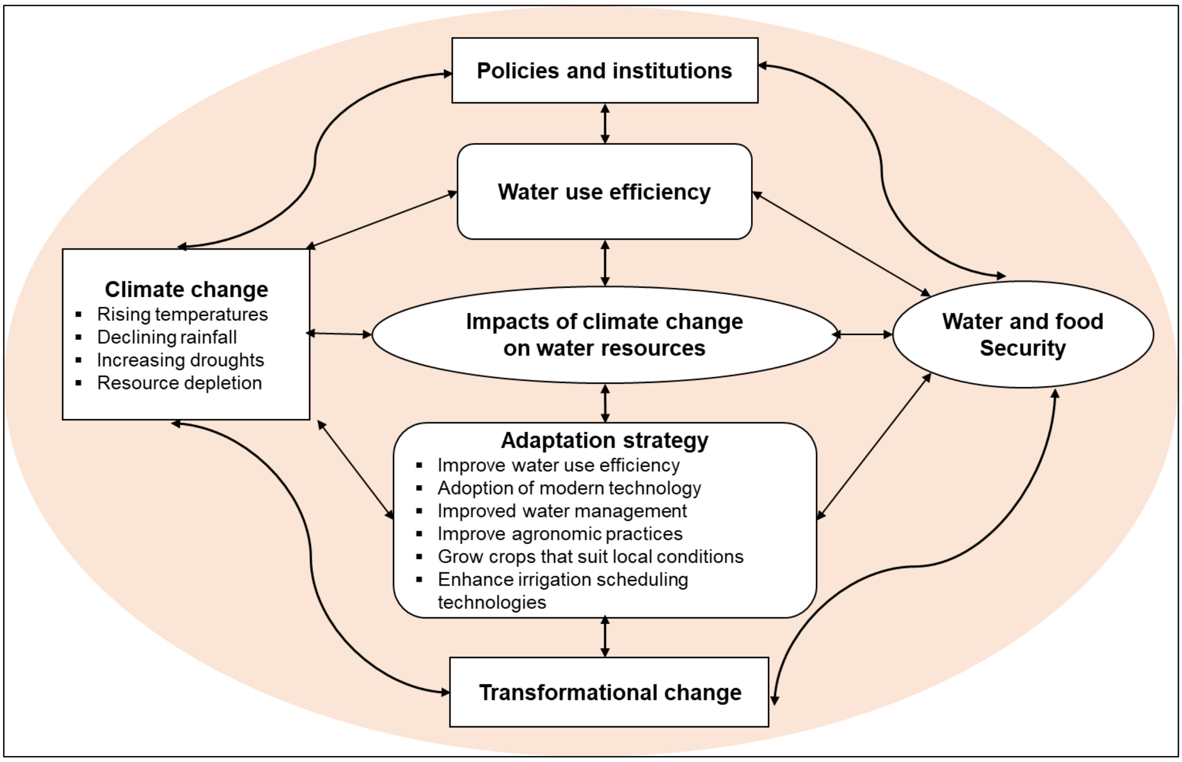

Figure 3. Conceptualised pathways towards climate change adaptation and resilience in the water sector.

The water sector climate change adaptation thematic areas address the drivers of climate change that impact water resources. The implementation of these fundamental themes is envisaged to enhance water and food in the country. Climate change adaptation through transformational, multicentric and circular approaches inform policy- and decision-making on managing resources effectively without transferring challenges to other sectors (Nhamo et al., 2019b; Nhemachena et al., 2020). Responses to climate change in the water sector range from autonomous coping strategies to reactive interventions towards climate variability and extreme weather events, and proactive interventions to long-term changes in climate (Mpandeli et al., 2019). Reactive/autonomous adaptations refers to deviations from current production and management practices (such as changes in crop mixes, and crop varieties) in response to changes in local climatic and growing conditions (Iglesias and Garrote, 2015). Proactive interventions, on the other hand, include planned policy and investment decisions to enhance adaptive capacity of target water and agricultural systems, such as investments in efficient irrigation systems and new crop varieties (Nhamo et al., 2019b). While reactive/autonomous responses are useful in the short-term, it is proactive interventions that contribute to long-term adaptation and sustainability. One such initiative is to promote and cultivation of indigenous underutilised crops that are suitable for local harsh environmental conditions and do not require a lot of water.

Policies on climate change adaptation need to be aligned to governance capabilities such as (a) reflexivity, (b) resilience, (c) responsiveness and (d) revitalisation (Nhamo et al., 2019b). Reflexivity is the ability to deal with a variety of problem systematically and continuously as they emerge; resilience is the ability to bounce back to the original basic state of function after a perturbation; responsiveness is the ability to deal with dynamic demands and expectations, and revitalisation is the ability to reignite policies and ensure their continuous application (Magidi et al., 2021; Nhamo et al., 2016). Ideally, these approaches must be flexible to allow upscaling and downscaling, depending on and in response to the prevailing challenges at local and transboundary scales. In addition, adaptive management, which allows for iterative decision, is needed to manage climate change risk and uncertainty. Table 1 provides some of the climate change risks on water and the adaptation strategies.

Table 1. Climate change risks on agriculture and adaptation strategies

Climate Risk	Proposed Adaptation Strategy
Increasing climate variability, frequency and intensity of extreme weather events.	Access to climate information and services for improved decision-making. Early warning systems to mitigate the impact of extreme weather events such as drought and floods.
Decreased availability of freshwater resources in waterbodies due to increased open water evaporation.	Promoting water efficient irrigation technologies and climate smart agricultural practices that maximise water productivity, i.e., more crop per drop. Timing of crop production calendars to maximise irrigation water use in dams and reservoirs in order to mitigate losses to open surface evaporation.
Increased danger of water pollution and decreased water quality, which may cause water borne diseases.	Improve on agronomic practices and reduce nutrients from reaching water bodies.
Decrease in crop productivity due to increasing rainfall variability, decreasing rainfall totals and shifting seasons.	Promote water efficient irrigation technologies and strategies such as drip irrigation and deficit irrigation, respectively. Promoting the breeding of drought tolerant and water efficient crops suitable for low and variable rainfall environments. This would also include promotion of underutilised indigenous and traditional crops that have shown adaptation to these environments. Shifting seasons and season duration can be addressed by shifting planting dates from traditional dates as well as matching varieties to environments, e.g. where seasons are becoming shorter, the promotion of early maturing varieties would be suitable. Improving access to water in some areas will help to extend the length of the season and may facilitate all year cropping.

Increasing temperatures result in heat stress and the spread of pests and pathogens.	The breeding and promotion of drought and heat stress tolerant crops that are adapted to extreme weather conditions. This would also include promotion of underutilised indigenous and traditional crops that have shown adaptation to these environments. Cultivation of crops with resistance to pests and diseases as well as climate smart agricultural practices that promote greater crop diversity and promote biological control of pests and diseases. In some cases, adaptation may have to include controlled environment production (tunnels and greenhouses), especially for high value and sensitive crops.
Increased incidence of floods and flash floods because of sudden heavy downpours. This is also associated with erosion of the topsoil and loss of carbon from topsoil.	Develop and promote rainwater harvesting and conservation practices to capture and store the excess rainfall and save it for use during dry periods. This will also contribute to extending season length by increasing access to water. Cultivation of cover crops and promotion of climate smart agricultural practices that promote permanent ground cover to mitigate runoff.

IMPLICATIONS TO LOCAL GOVERNMENT WATER SECURITY AND THE NEED TO IMPROVE ADAPTIVE CAPACITY

The South African water sector is expected to be significantly impacted by projected climate change. Such experiences have already been witnessed during the recent El Niño event, and the entire water services chain is vulnerable to the effects of climate change, from the raw water source, through to the purification and distribution processes and subsequent wastewater treatment. Increased temperatures will affect existing water treatment infrastructure and conveyance systems. In this regard, storage tanks, flocculation chambers, and the pipeline network used for water distribution may be exposed to increased corrosion as a result of higher temperatures. In turn, an increase in extreme events, such as floods, may damage infrastructure. An increase in temperature will also lead to a concomitant increase in water demand and use despite a decrease in available water at the source due to higher rates of water loss, especially from dams. This will result in an increased level of pollutants in water resources, which will translate to an increase in the cost of treatment, an important area for municipalities to be able to put in place the necessary plans to adapt to these changes.

All of these changes will be an added burden to municipalities, who are already having to cope with eradicating service backlogs in support of improved service delivery, ensuring proper operation and maintenance of water and wastewater systems and ensuring water security amid rising demand and dwindling water supplies. To assist with addressing above challenges guidelines dealing with the selection of relevant water sector adaptation technologies and approaches for specific climate change impacts over the short-, medium- and long term have been developed (WRC Report TT 663 – Dube, et al., 2016). The concept for adaptation articulated in these guidelines is to provide solutions that can be applied across various geographical settings and municipal capabilities, thus setting the basis for adaptation to be planned and applied where and when required, especially in the most vulnerable regions and within suitable timeframes (Figure 4).

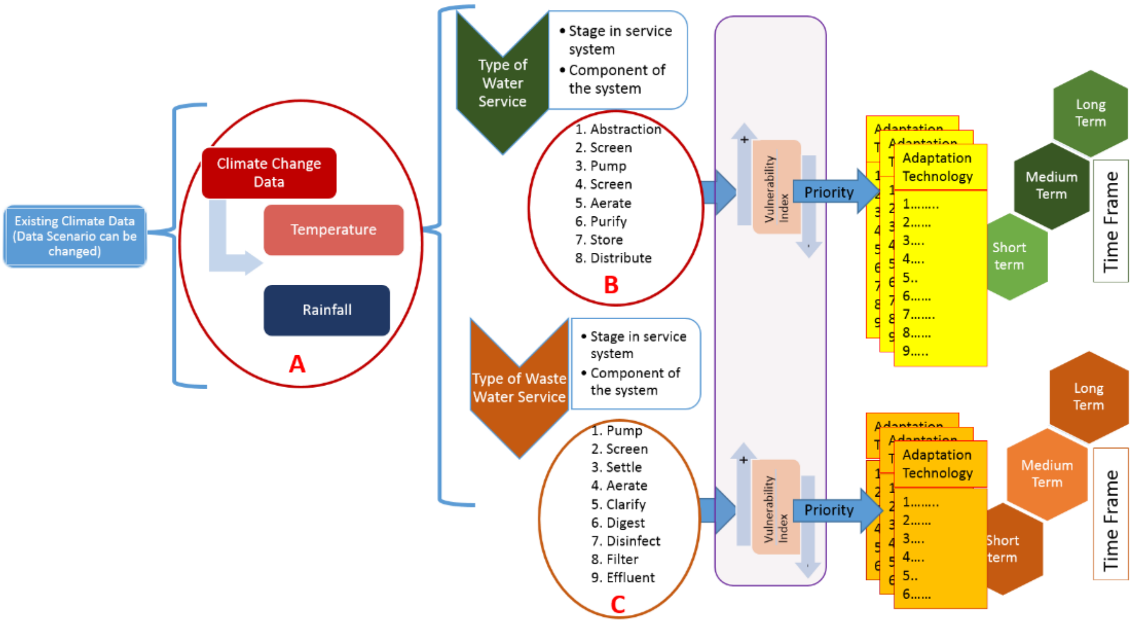

Figure 4: Schematic illustration of the adaptation guide highlighting climate change impacts and the adaptation process

When municipalities compose their climate change adaptation response, as they are now being encouraged to do, they should consider their specific local circumstances. The options selected should optimise prevailing and anticipated environmental, social, economic and cultural aspects. Options should also be associated with a favourable economic assessment after accounting for the social components for which monetary returns are not expected. In this regards, rural municipalities are considered to have the poorest adaptive capacity making them more vulnerable to the additional stresses, while large urban municipalities are associated with a higher level of service delivery, thus reducing vulnerability. The Blue- and Green Drop scores also point to the nature of vulnerability in water and wastewater services. A poor score also means that the institution and the service delivery process are highly vulnerable to the impacts of external factors such as climate change. As such, these vulnerabilities have to be dealt with before accounting for climate change. Water sector bylaws and management of restrictions are currently evolving at a slower pace which do not necessarily cater for the threat of climate change to water service provision but rather attempts to respond to disasters already in dire situations. In this regard, plans for implementing climate change adaptation are still failing to make it onto the list of prioritised projects for the municipalities, even though several climate change strategies may have been developed. This often results in failure of cities to respond to disruption in water supply for example in case of extended and unusual drought which are the modern features of the changing climate (Dube, et al., 2016).

CONCLUDING REMARKS

Since South Africa is a fully integrated member of the global community, international protocols and obligations to which the country is signatory determine the nature of response adopted by the South African national government. In turn, this needs to be translated into local strategies, programmes and projects to ensure successful implementation. Adaptation technologies and approaches should aim to meet increased resilience to climate change and should not be seen to be compromising local development but rather help to improve efficiency and sustainability. The science and trends that lead to adaptation selection must be well considered and precise, based on local information. This should in a way help to strengthen South Africa's international obligations to climate treaties in a bottom up approach and also encourage societal benefits from ecosystem-based adaptation within municipal scales with adaptation technologies and approaches that are specific to South Africa's vulnerability and sensitivity to climate change. The focus should mainly be on improving the state of services through adaptation, and averting loss and damage as they occur. In highly vulnerable areas, modular structures that can be easily modified should be utilised. Win-win adaptation technologies can also be utilised. These are technologies and approaches that are effective irrespective of the kind of climate change impact that occurs.

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