Managing Water as a Constraint to Development: How will climate change impact agricultural water requirements in the Berg WMA?

SECTOR BRIEF: AGRICULTURE

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KEY INSIGHTS

Swartland, Stellenbosch, and Drakenstein should be targeted for intervention.

These three municipalities have the highest concentration of high-value irrigated crops (primarily stone fruit and wine grapes) and require the largest amount of irrigated water, currently and into the future. Barring any additional allocations or augmentation schemes, the irrigation supply deficit is most keenly going to be felt in these municipalities, both in terms of economic and social opportunity cost. If no additional water is secured in the future, crop switching to more water efficient crops, along with investment in water efficiency technology, should be encouraged.

Competition between urban and agricultural water users will escalate.

Because 1 m^3 of agricultural water adds significantly less economic and social value than the value from non-agricultural water, a reduction in water supply for agricultural purposes would not severely impact the entire region. However, it would have very significant economic and social impacts on local economies that have a high concentration of agricultural value, primarily Swartland, Stellenbosch, and Drakenstein. The competition between urban and agricultural water uses is being experienced in the current drought, and will continue into the future as climate change places upward pressure on crop water requirements.

The long-term viability of the wine grape industry should be evaluated.

Grapes, largely wine grapes, consume most of the irrigated water in the region, approximately 79%. As the regional climate changes, grapes are expected to increase water requirements by 34% by 2040. While grapes require an average amount of water per hectare when compared with other crops grown in the area, there are alternative options for crops that offer high economic value, but low water intensity. Assuming farmers have information readily available to them in order to make informed trade-offs, crop switching could provide a solution in the face of increasing water scarcity.

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1. Background

The Berg Water Management Area (WMA) is a heavily used system, supplying water to a number of local municipalities, including the City of Cape Town metro, as well as a significant amount of the agricultural demands across the region. It is also a 'constrained catchment, meaning all readily available water is already allocated.

Climate change, population growth, urbanisation, and economic development place increasing pressure on constrained systems. As the Berg WMA approaches a system-wide water supply deficit in 2019, the social and economic impacts of the deficit will be felt throughout the region. Water intense sectors, like agriculture, will be hit the hardest.

This brief provides estimates of the current and future irrigated water requirements in the region. It details the predicted magnitude of the future water supply deficit in the agriculture sector and the economic impact this will have on local economies, highlighting areas and crops that are most at risk.

This information and methodologies detailed within this brief are intended for government planners, agricultural industry associations, commodity organisations, and agricultural research associations to better plan for the future impacts of climate change. Key messages can be utilised to inform farmers of the localised impacts of future water constraints and to identify possible options for adaptation.

2. What is the value of water in the agriculture sector?

In order to weigh the economic impact of one water use versus another, it is necessary to place a value on water. Within this model, we examined the economic dimension, **"value per drop",** and social dimension, **"jobs per drop",** of water within two categories: the agricultural value and non-agricultural value, "urban". The Rand value and number jobs generated for each category was divided by the amount of water used in order to get a value per m³.

Table 1: The economic and social value of water in the Berg WMA

	Agricultural use	Urban use
Value per drop	R11 per m^3	R993 per m^3
Jobs per drop	234 jobs per m^3	4,201 jobs per m^3

When considering value per drop and jobs per drop, agriculture is relatively low when compared to other sectors. However, agricultural value varies significantly across municipalities and crops, and this value assessment does not take into account the full-value chain that agriculture contributes to.

Local economies outside of the City of Cape Town that have a high concentration of agricultural value, specifically Bergrivier, Swartland, Stellenbosch, and Drakenstein, are especially at risk (Figure 1). Constraints in water for irrigation would significant impact the generation of value add and employment in these areas.

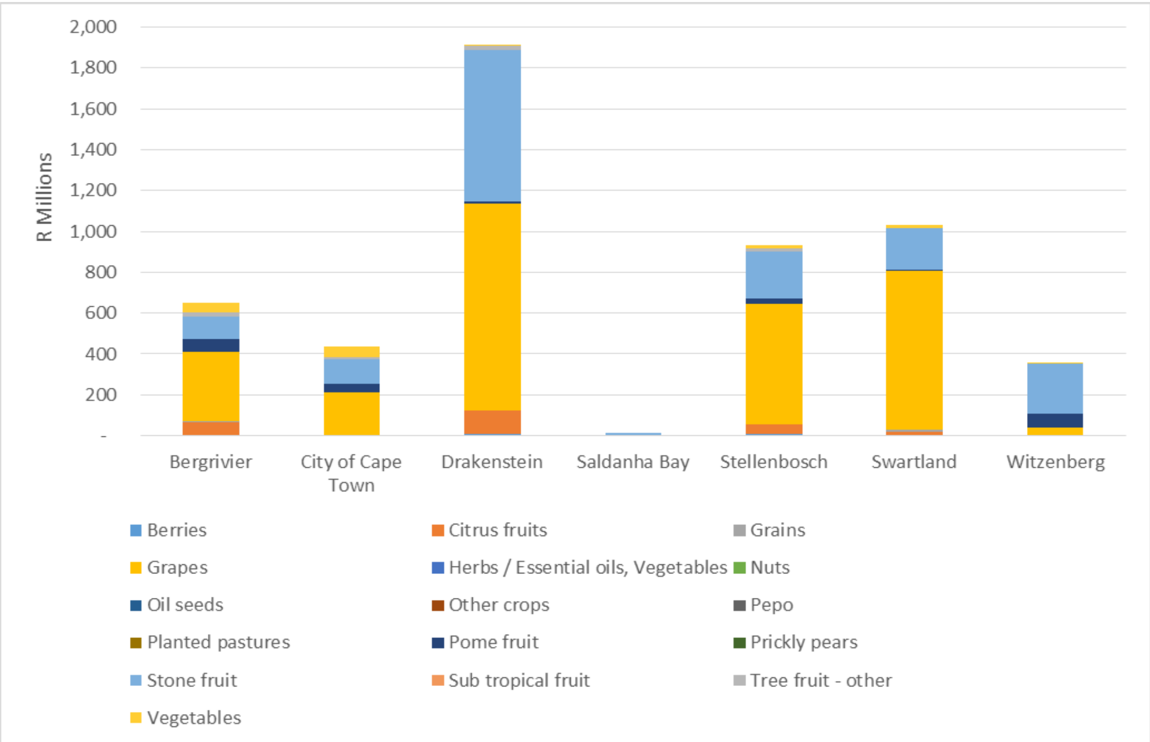

Figure 1: Average value of irrigated agriculture per year by municipality in the Berg WMA (R millions)

The average value of water for different crops also varies. The concentration of value in Swartland, Stellenbosch, and Drakenstein is due to a large number of high-value fields, primarily stone fruit and wine grapes. This is reflected in the fact that 77% of the irrigated crops in the Berg WMA are grapes and 10% are stone fruit. The social value of each crop aligns with the distribution of value add, with grapes contributing 85% of total agricultural employment and stone fruit contributing 7.4%.

When compared to the average water requirements by crop and municipality, the information in Figure 1 can be used to identify which crops are suitable for crop switching i.e. which crops generate high economic and social value when compared to water intensity (Box 1).

3. How much water does the agriculture sector need?

The water requirements of irrigated agriculture in the region were calculated using a bottom-up approach. A flyover survey of the area was used to define the borders of all cultivated fields, which were then defined by crop type, irrigation method, and total field size. Monthly irrigation requirements were calculated at field level by subtracting monthly rainfall estimates with monthly evapotranspiration values for each crop to determine the water deficit to be covered by irrigation. The irrigation requirements by field could then be aggregated by crop or by municipality.

For more information on the methodologies used to calculate current and future irrigated water requirements see the full technical report: https://www.greencape.co.za/content/focusarea/water-for-sustainable-development.

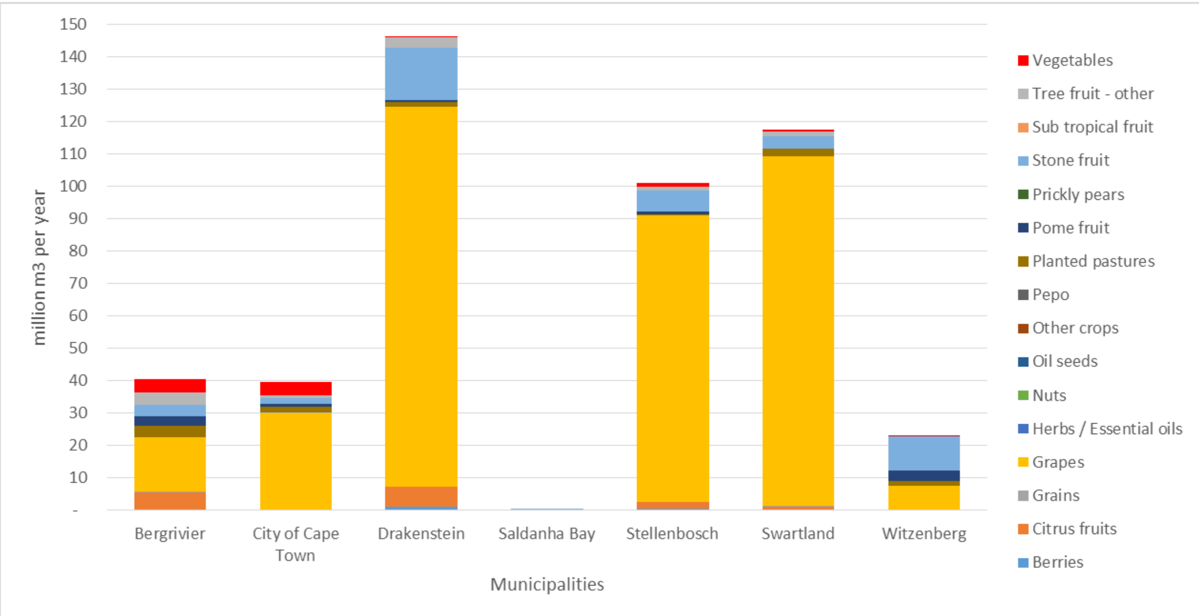

Figure 2: Irrigated agriculture water requirements per year in the Berg WMA

Grapes, largely wine grapes, consume most of the irrigated water in the region—estimated at approximately 79%. Drakenstein, Swartland and Stellenbosch are the largest agricultural water consumers and these are predominantly wine growing regions (Figure 2).

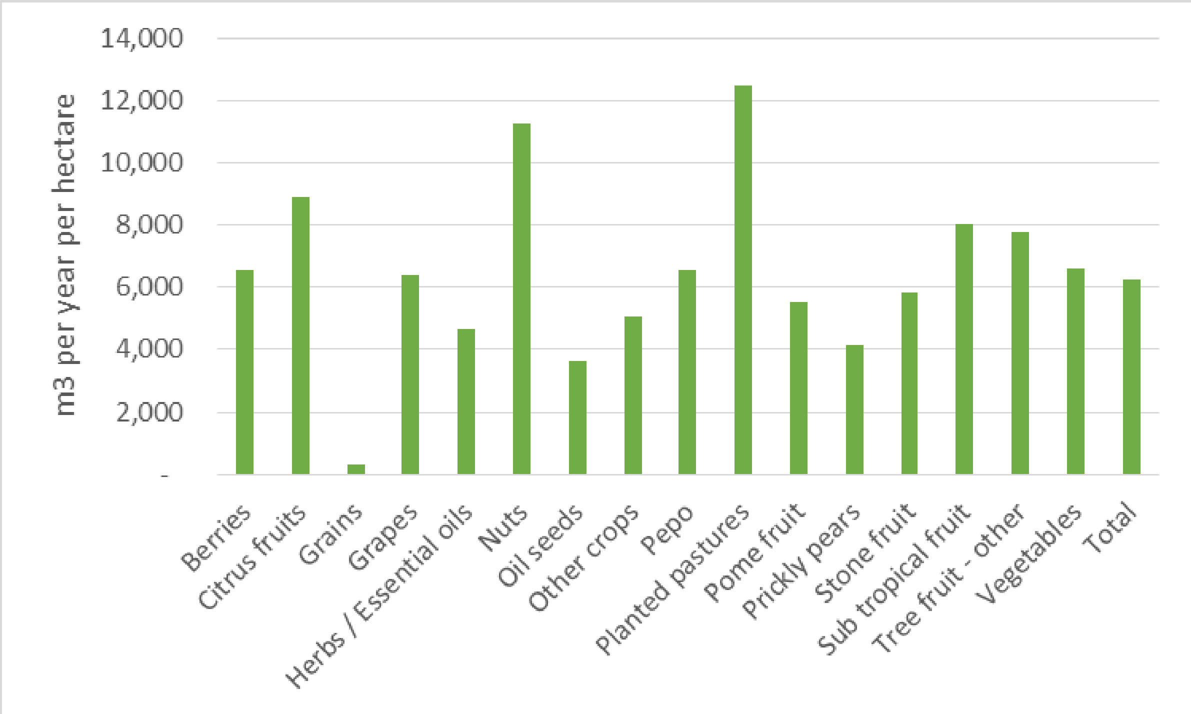

Figure 3: Average water requirement per hectare per year

While grapes require an average amount of water per hectare when compared with other crops grown in the area (Figure 3), there are alternative options for crops that offer high economic value, but low water intensity. Assuming farmers have information readily available to them in order to make informed trade-offs, crop switching could provide a solution in the face of increasing water scarcity (Box 1).

Box 1: A case for crop switching: the economic and social value of irrigated crops compared to water intensity

The economic value, "value per drop", and social value, "jobs per drop", that crops generate within each municipality can be compared to amount of water each crop requires. Figure 4 highlights the variance that exists between crops with regard to economic and social value generated from water use for entire region.

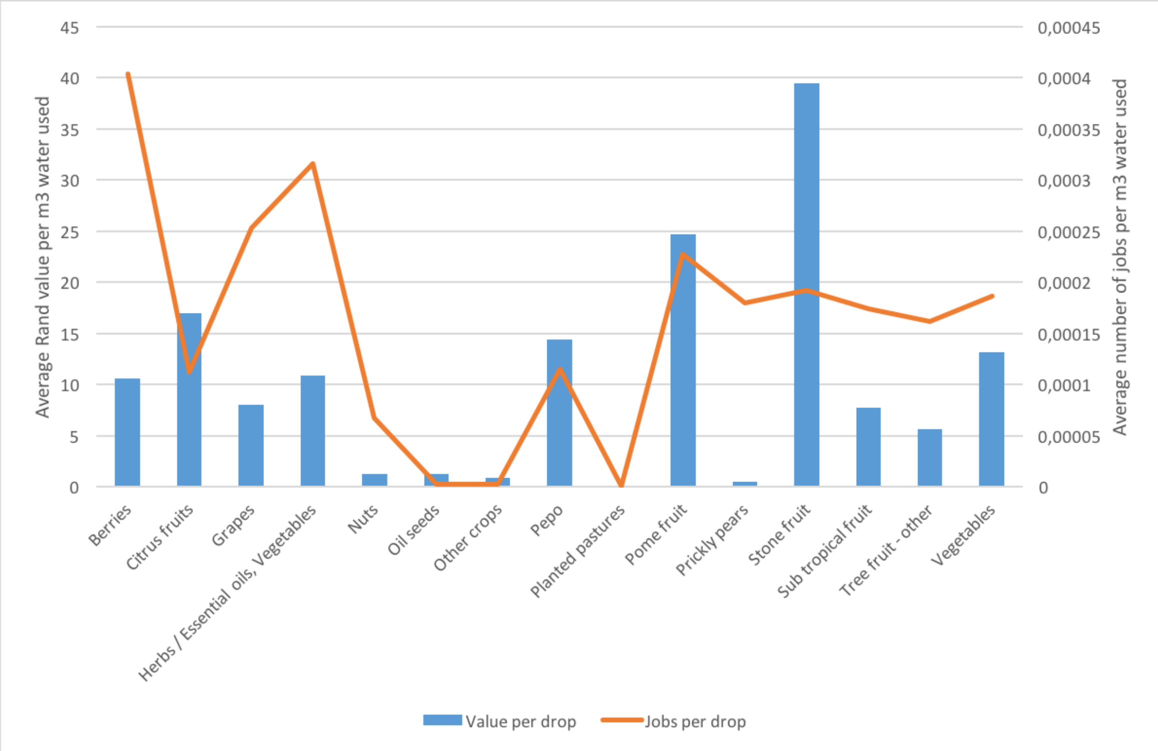

Figure 4: Value per drop and jobs per drop by crop in Berg WMA

The results indicate that **there are several crops that could provide an alternative to grapes when water supply becomes a constraining factor**. Pome fruit and stone fruit require less water than grapes and generate the highest economic value per cubic metre of water. Herbs and essential oils, pome fruit, berries, vegetables also require less (or equal) water than grapes and generate more jobs per drop.

4. How will climate change impact agricultural water requirements in the future?

While it is certain that climate change will play a role in altering both future water supply and future water requirements, it is uncertain what the magnitude of the impact will be. As a highly water intense sector, agriculture will be particularly impacted by the changing climate, with some municipalities affected more than others, based on geographical location, crop composition, and the sector's share of local value add and employment.

An estimation of future water requirements for irrigated agriculture was generated for the years 2025 and 2040. The crop and irrigation type were assumed to maintain constant, but climatic conditions (mean monthly rainfall and temperature) were updated based on several climate models sourced from UCT's Climate and System and Analysis Group (CSAG).

Without any degree of certainty as to which climate model best represented the future climatic conditions in the region, three climate models were selected to represent the best, worst, and moderate case scenarios—FGOALS, GFDL-ESM2G, and CANESM2. For each model, low and high emission scenarios were considered. Figure 5 and Figure 6 illustrate temperature and effective rainfall projections for each climate model used, including historical data (1979-2014).

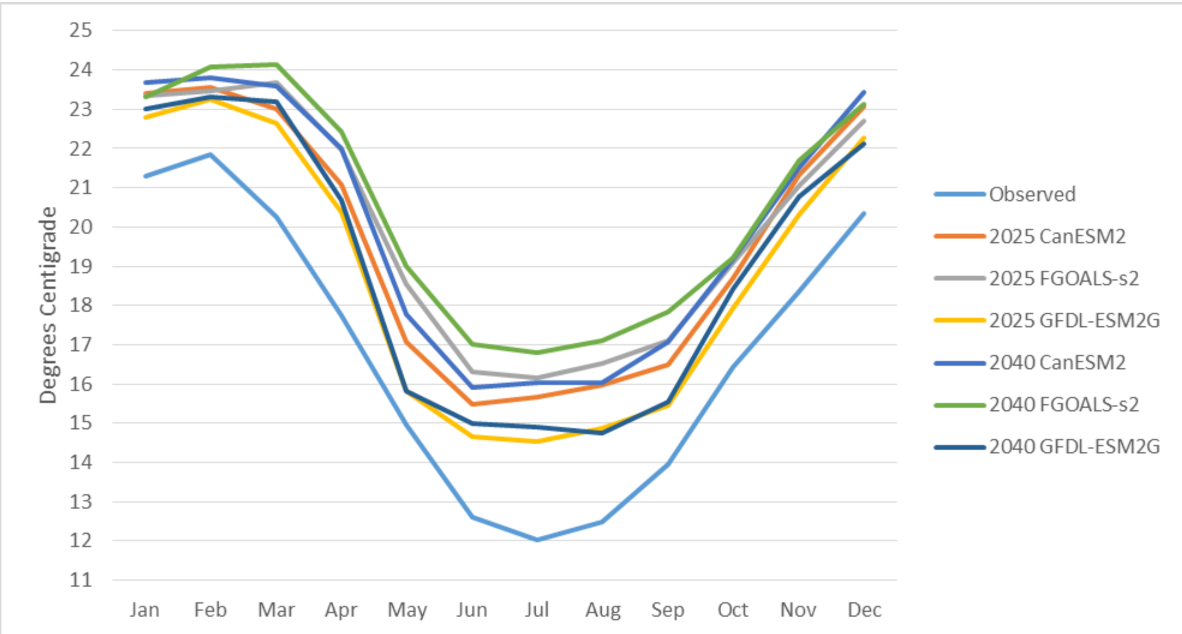

Figure 5: Mean monthly temperatures in the Berg WMA

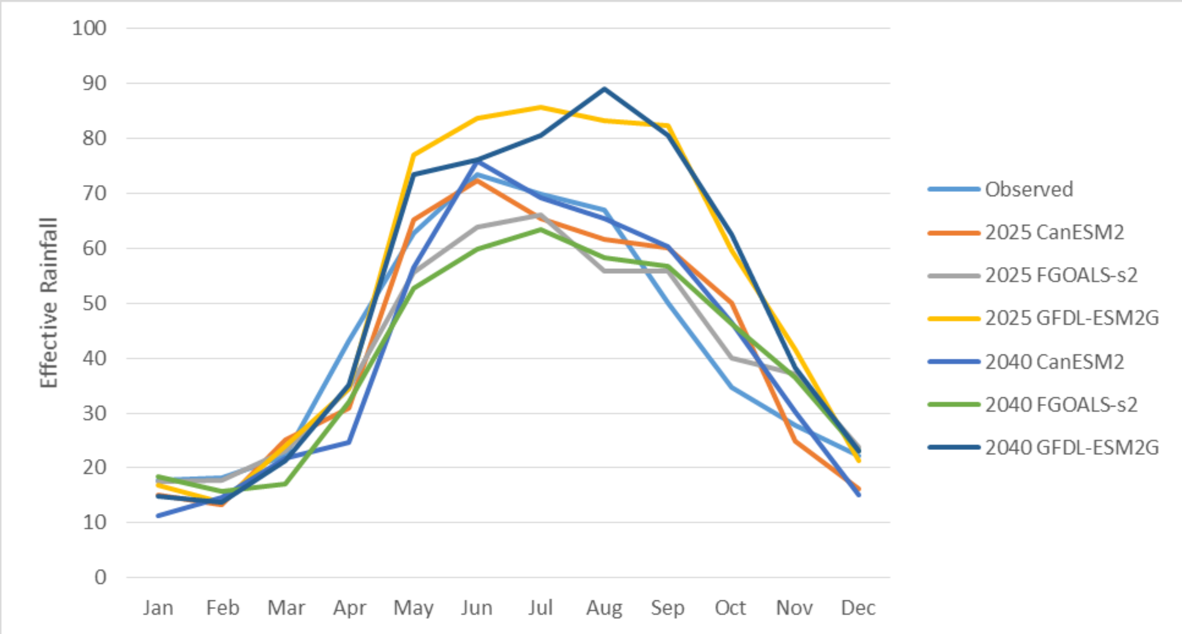

Figure 6: Mean monthly effective rainfall in the Berg WMA

When applied to the Berg WMA region, these models predict the following trends:

- **Temperature:** All climate change models predict higher temperature than the currently observed trends and this will increase the evapotranspiration rates of the crops.
- **Rainfall**: Rainfall predictions are too variant to predict changes in rainfall volume accurately in the future. However, the results do show a shift in rainfall patterns with later rain expected in autumn and spring.

Under all climate change models, **irrigated water will require more water to remain sustainable,** with a consistent increase between 2025 and 2040 (Figure 7).

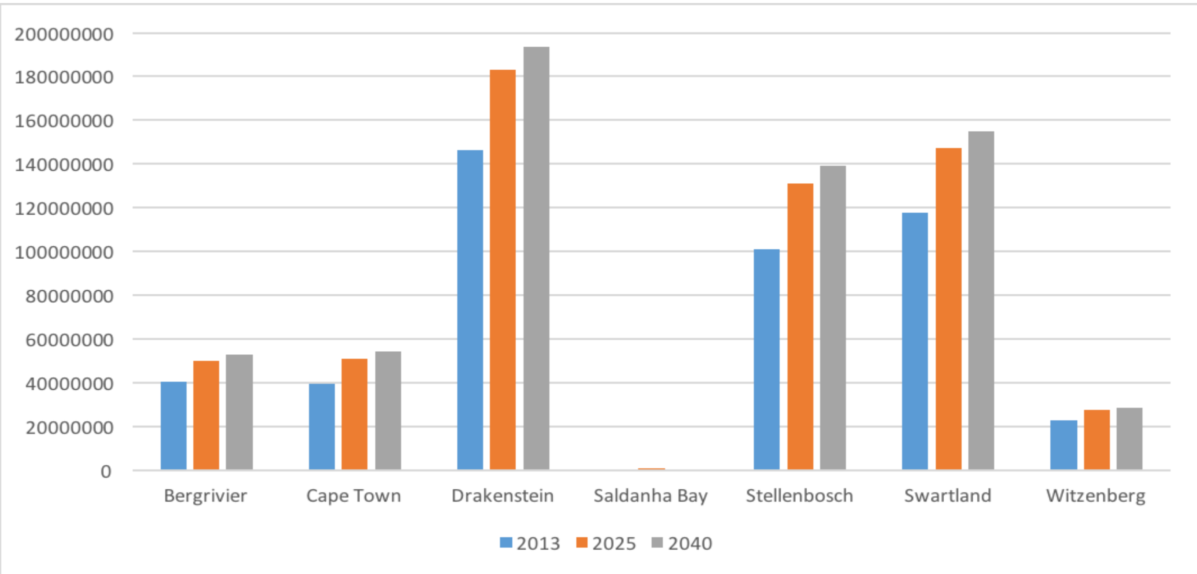

Figure 7: Agricultural water requirements over time by municipality (m3 per year)

Utilising the results from CANESM2 (the climate model best correlated with historical data and the most conservative in terms of measured impact), the impact on the agricultural water demand was predicted for each municipality and for each crop (Figure 8 and Figure 9).

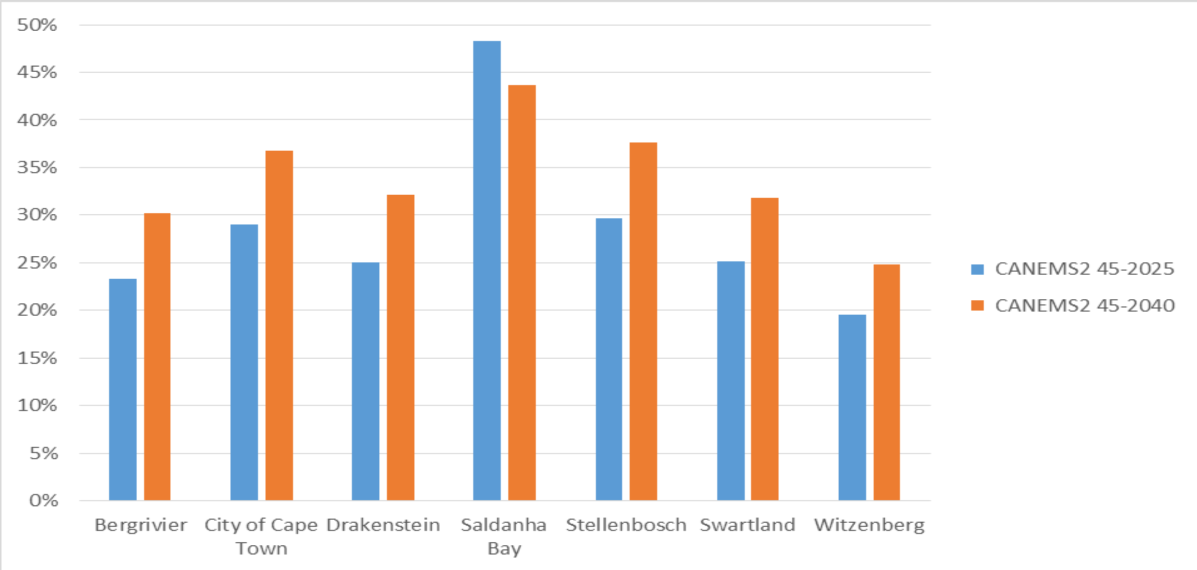

Figure 8: % increase in irrigated water requirements by municipality in 2025 and 2040 using CANEMS2 45 climate model

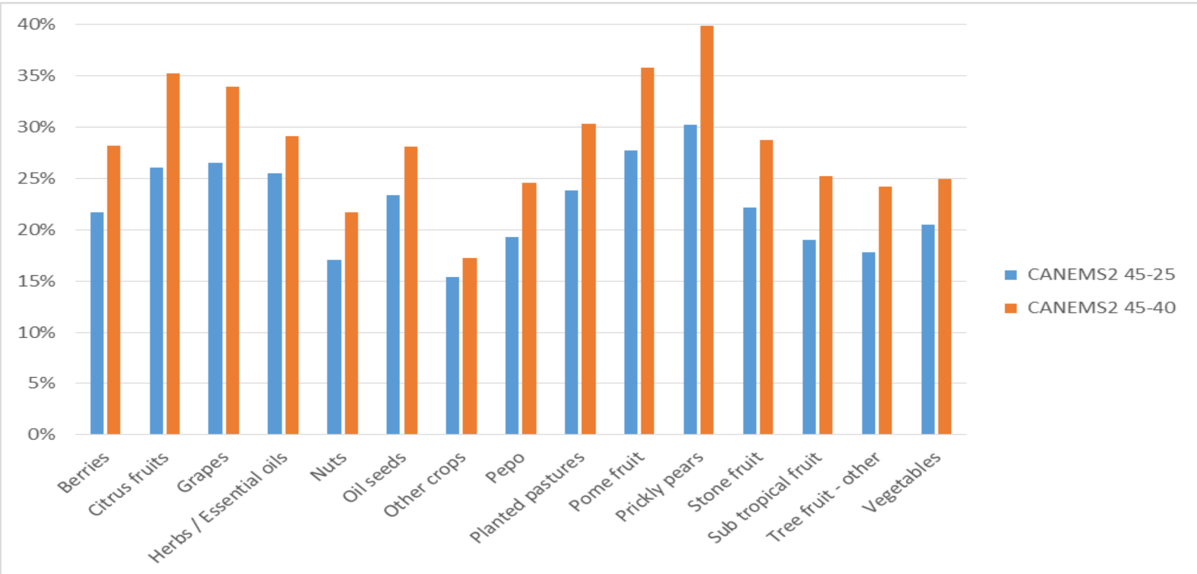

Figure 9: % increase in irrigated water requirements by crop in 2025 and 2040 for the Berg WMA (excluding grains)

Saldanha Bay, City of Cape Town, and Stellenbosch are expected to experience the biggest percentage increase in agriculture water demand. In terms of total volume, Drakenstein, Swartland

and Stellenbosch continue to require the largest volume of irrigated water in the Berg WMA in 2025 and 2040.

The most important crops in the region—grapes, stone fruit, and citrus fruit—are expected to increase water requirements by 34%, 29%, and 35%, respectively. If no additional water is secured in the future, crop switching to more water efficient crops, along with investment in water efficiency technology, should be encouraged, especially in Drakenstein, Swartland, and Stellenbosch.

5. What is the magnitude and cost of the future water supply deficit?

The economic and social value of water used for irrigation, and the intensity of irrigated agriculture in local economies, can be used to illustrate how vulnerable an area is to water constraints. In order to better understand how water availability may impact the agriculture sector, the future **water supply deficit** was calculated assuming that no water augmentation schemes are implemented, and current water supply levels, land use patterns, and irrigation efficiency all remain the same (Figure 10).

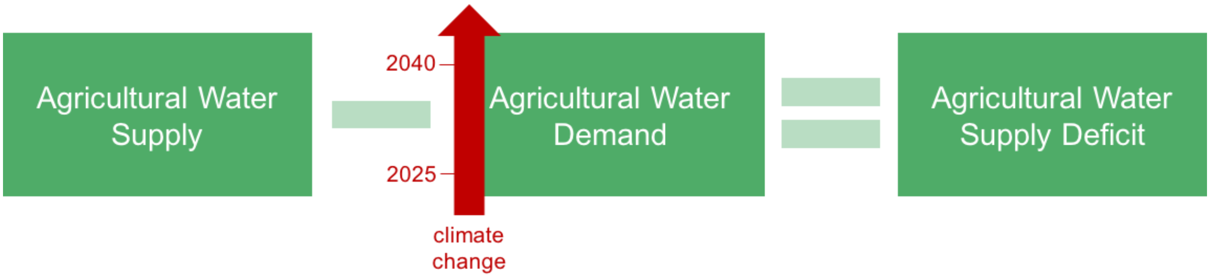

Figure 10: Simplified representation of the hydro-economic model

The allocation of water to agriculture is capped, nationally as well as within the region. Into the future, allocations are unlikely to increase, especially when considering the drought in the region, as well as the number of outstanding water use license applications from the Water Services Authorities in the WMA. **Therefore, any increase in agricultural demand will result in a supply deficit.**

The existing allocations were deducted from the predicted **agricultural water demand** in 2025 and 2040 in order to determine the magnitude of the supply deficit in the future (Figure 11).

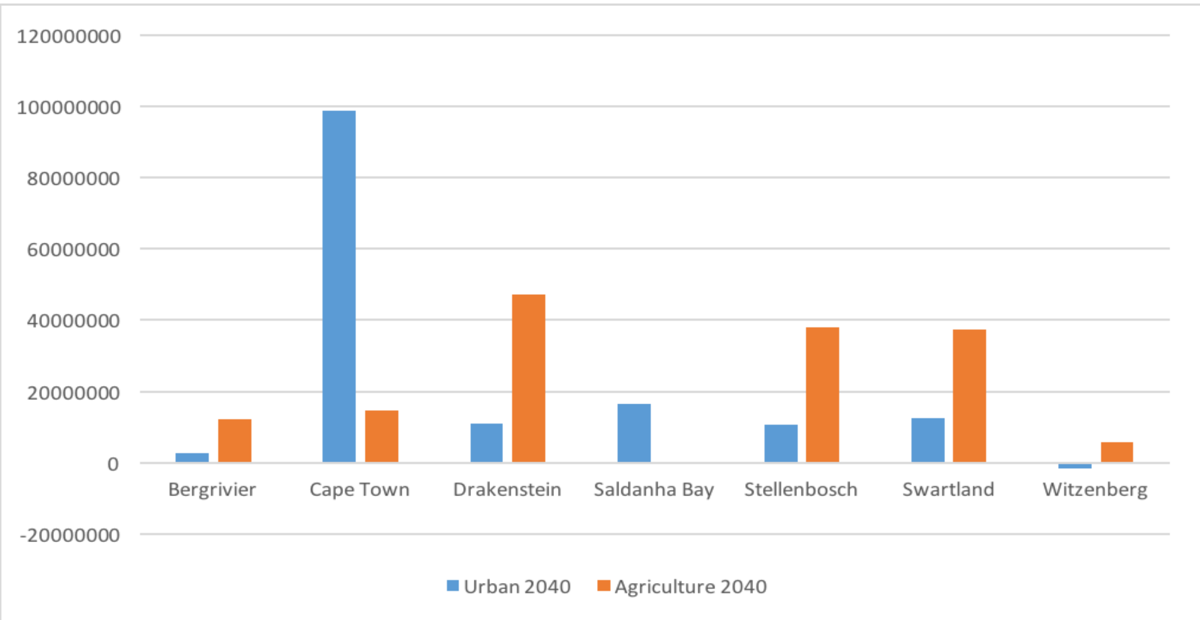

Figure 11: Urban and agricultural supply deficit in 2040 (m^3/a)

The increase in irrigation requirements is substantial. Barring any additional allocations or augmentation schemes, the **irrigation supply deficit is most keenly going to be felt in Drakenstein, Stellenbosch, and Swartland**, the municipalities with the highest concentration of agricultural value as well as the highest irrigated water use.

While the difference between urban and agricultural water supply deficit varies by municipality, by 2040 there is almost an even split between the agricultural and urban water supply deficit for the entire region (**Error! Reference source not found.**). However, even though the deficit will be experienced equally, the massive difference in "value per drop" and "jobs per drop" generated from agricultural water use and urban water use means that the economic impacts of the urban water supply deficit will be felt much more severely throughout the region (Box 2).

Box 2: Urban versus agricultural water supply opportunity cost

Irrigated agriculture water requirements increase substantially in 2025 and 2040, but the irrigated water supply deficit is valued at a much lower opportunity cost due to the significantly higher value created by urban water use (Figure 12 and Figure 13).

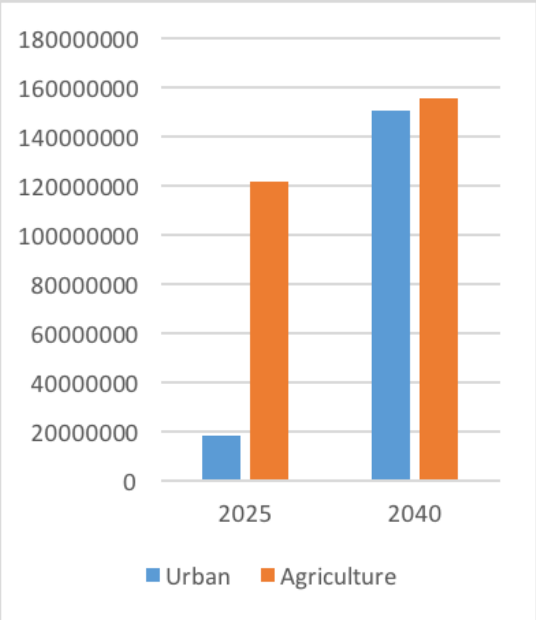

Figure 12: Total urban and agricultural supply deficit (m³/a)

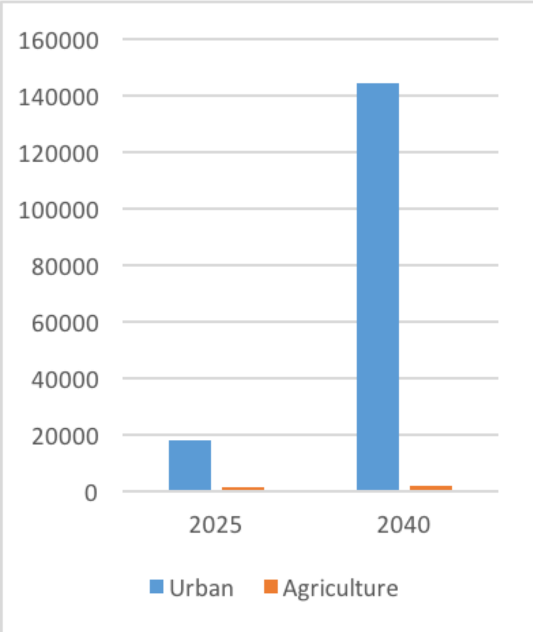

Figure 12: Total urban and agricultural opportunity cost in R millions

This disparity in the opportunity cost of agricultural water versus urban water in 2025 and 2040 highlights the difficulty that the agriculture sector will have in justifying further water allocation in the future. If water supply augmentation schemes come on board, it is likely that priority will be given to urban activities as they provide much more economic and social value than agricultural activities.

However riparian farmers who have the ability to abstract water upstream may interfere with water destined for downstream dams that supply urban populations (a conflict that has arisen during the current drought). This type of competition between urban and agricultural water users is likely to increase into the future.

6. The Way Forward

Projected water supply deficits in the near future will have major implications for the agriculture sector, impacting the livelihoods and wellbeing of rural municipalities and populations in the Berg WMA.

At the municipal and provincial level, difficult trade-offs will need to be made in order to ensure that limited water resources are used equitably, and new water resource are developed strategically in order to make the most of development opportunities. Due to the massive difference in the economic and social value generated by agricultural and urban water use, it is anticipated that any new water supply augmentation scheme will be prioritised for urban uses.

In light of this reality, both public and private sector actors within the agriculture sector will have to channel significant capacity and resources towards:

1. Improving the productivity of agricultural water through increased water efficiency and concentration of high-value crops.

Barring any additional allocations or augmentation schemes, agricultural users must increase the productivity of their water resources. Farms should be encouraged to switch to crops that offer high economic and social value, but low water intensity, such as pome fruit, stone fruit, and herbs and essential oils. Investment in water efficiency technology (shade cover, remote sensing, etc.) should be encouraged. This is especially true in Swartland, Stellenbosch and Drakenstein, the municipalities with the highest irrigated water requirements, currently and into the future.

2. Adopting new strategic planning approaches in order to prioritise crops/regions that generate the highest economic and social value per drop.

The methods and results from the hydro-economic modelling exercise detailed in this brief should be integrated into existing agricultural planning processes. The methodologies used within the model should be expanded upon and refined at a much more detailed level in order to help agricultural planners support farmers in particular areas. Climate change projections should be utilised to better understand the impact on agriculture water requirements for particular regions and crops. As fly-over survey data is updated, the hydro-economic model can be updated with new field data to assess what changes farmers have made since the 2013 data was collected. Analysis of the differences over time can be used to identify if farmers have switched crops or irrigation techniques and assess whether those changes have resulted in a decrease in irrigated water requirements. This information should be utilised to support farmers in decision-making and planning processes for the future.

Find out more

This brief covers key findings from a three-year study, “Managing water as a constraint to development with decision-support tools that promote integrated planning: the case of the Berg Water Management Area”, funded by the Western Cape Government and Water Research Commission and conducted by GreenCape, with support from the University of Cape Town (UCT) African Climate and Development Institute (ACDI). The aim of the study was to better understand the interdependent relationship between the Berg WMA economy and current and future water availability. It also aimed to develop actionable tools and insights for decision-makers to integrate water resource and development planning.

For the full project report and the decision-making tools developed, visit: https://www.green-cape.co.za/content/focusarea/water-for-sustainable-development.

For support on taking further action, contact: Claire Pengelly, claire@green-cape.co.za.