WATER RESEARCH COMMISSION

June 2014
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

POLICY BRIEF

Climate change

Decision support system for water boards

A completed Water Research Commission (WRC)-funded project on the development of climate change adaptation strategies has seen the creation of a decision support system for selected South African water boards.

Background

Climate change adds an additional dimension of concern to the range of issues (such as development, mismanagement and pollution) that are already causing the deterioration of South African water resources.

South Africa naturally has a highly variable climate, and this, along with a limited capacity for preparedness makes the country very vulnerable to climate change and its effects.

This project aimed to quantify changes associated with the near future climate change and socio-economic development, with inclusion of the uncertainty linked to both these changes in order to develop a decision support system that incorporates those uncertainties.

The focus of the project was on the water-supply area of a moderately-sized water board, namely the Buffalo River for the Amatola Water Board area.

Methodological approach and findings

Methodology entailed identifying potential impacts and threats to sustainable water services delivery posed by climate change, as well as the uncertainties associated with these, with regards to changes in water quantity, water quality and socio-economic developments. The project further assessed risks and vulnerabilities (including uncertainties in predictions) to climate change for water boards and their capacity to fulfil their mandate on water services delivery.

A strategy and monitoring network for water audits was also developed in order to monitor indicators of change. In this regard Thresholds of Potential Concern (TPCs) were derived for water quality and quantity issues for water boards related to raw and potable water, discharges, prices effects, etc, based on the outputs of the climate models.

Lastly, a decision-support framework for an adaptive management strategy was developed to assess and modify water services delivery and development plans of the water boards in terms of infrastructure repair and developments, water conservation and demand management, water pricing changes and other associated issues.

A physically-based model, known as the Watershed Assessment Model (WAM) was set up to represent the complex water quantity and quality responses within the terrestrial portion of the hydrological cycle, based on detailed characterisation data (see Figure 1).

The WAM simulates each of the main constituents important to water quality and quantity (water, total suspended solids, biological oxygen demand, soluble and particulate nitrogen and phosphorus) within a watershed. Also, the Water Quantity Systems Assessment Model (WQSAM) was constructed as a water quality decision support system (WQDSS) for investigating future climate change and development scenarios.

Given that WQSAM interfaces with present modelling tool used within water resource management and provides an estimate of risk of certain water quality thresholds being exceeded, the WQDSS is shown to be a natural extension to models presently being used for water resource management in South Africa.

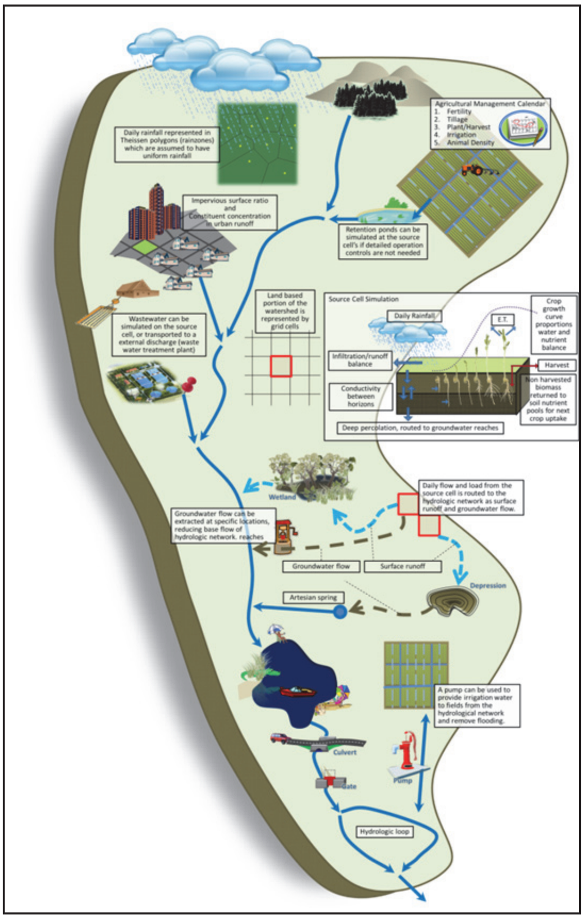

Figure 1: Conceptual watershed processes simulated in WAM.

The TPCs were adapted to relate to anticipated improvements in the present ecological state (PES) in the middle Buffalo River because of proposed decommissioning of three wastewater treatment works (WWTW) and the upgrading of the Zwelitsha WWTW. The improvements to the PES are anticipated in the middle Buffalo River between King Williams Town and Laing Dam, improvements to Laing Dam and improvements to the Yellowwoods River.

In addition, the TPCs were updated to remove unrealistic management options and to regionalise TPCs for upstream and downstream of the Nahoon Dam. The results of the water evaluation and planning model (WEAP) indicated that the planned improvement in infrastructure and transfers from the Wriggleswade Dam should be sufficient to satisfy the water requirements under the Intermediate Development Scenario, but not for the Upper Development Scenario, with a deficit of around 50.18 x 10^6 $m^{-3}y^{-1}$.

Recommendations

- In terms of potential climate change impacts, South Africa should assess the adequacy of its observation network, identify data gaps in the water monitoring network, improve data management and determine adequacy of hydrological and other models.
- It is important to recognise that uncertainty is not the same as not having confidence in the predictions, but rather it equates to having a probability associated with a specific prediction. One cannot avoid uncertainty by using a single climate model as that only leads to a wrong decision being made.
- Most sources of uncertainty in modelling are associated with imperfect knowledge about the inputs (i.e. climate variables or parameters describing the catchment response) or a lack of observations of the outputs (e.g. stream flow) and monitoring against which the model can be tested and refined. It is clear, therefore , that attempts to reduce uncertainty should be focused on improving our knowledge and understanding of the inputs and/or improving the monitoring of the outputs.
- One of the approaches that would potentially assist in reducing uncertainty is to try and improve the quantification of the upstream impacts and therefore determine what conditions of development are represented by the observed streamflows. The likely result of such an exercise would be a 'naturalised' observed streamflow record that would also include a band of uncertainty. We would, therefore, expect our natural flow simulations to have a similar band of uncertainty.
- Where streamflow observations do not exist, often useful to establish short-term and inexpensive (i.e. not using constructed gauging weirs) monitoring programmes to establish some key quantities related to the flow regime of a catchment. This may include low-flow responses during dry periods or high flow responses to single rainfall events.
- The use of satellite data to estimate patterns of variation (in space and time) of soil moisture and actual evaporation is recommended.
- The largest uncertainty occurs in topographically steep areas where rainfall gradients can also be steep. These areas are usually poorly represented by gauging networks. As with streamflow data, short-term field monitoring programmes can be of assistance in quantifying spatial rainfall patterns, but there is no real substistute for well-managed and spatially representative continuous rainfall data collection that remains active for many years.
- Understanding the dynamics of interaction between surface runoff and storage (soil water) processes and

groundwater (recharge as well as groundwater contributions to streamflow) processes is important for simulating the low flow regime of catchments. While it is often difficult to be confident about the results of using measured physical basin property data to estimate parameters in an absolute sense, these techniques can be very valuable for identifying spatial variations in model parameters (in a relative sense) and expected catchment response. If such results are used together with limited observed streamflow response data there is a great deal of potential for reducing uncertainty.

Recommendations specific to Amathole systems

The report makes several recommendations specific to the Amathole water-supply system:

- Reinstating the streamflow gauging station on iZele River in order to monitor inflow into the Buffalo Rover.
- Installing a streamflow gauging station above the Nahoon Dam.
- Monitor the estuary water levels for the Nahoon River to account for both flow and tidal effects.
- Monitor and model evaporation from dams to reduce present day and future climate uncertainty when modelling reservoir storage.
- Monitor and collate water use data over time in terms of water requirements of various users, losses in the distribution and bulk water system. Notably, the population water requirements are the major contributor to the uncertainty in the total water requirements in the future and thus, reducing the uncertainty in the socio-economic development demands will go a long way in managing the system sustainably.
- Obtaining breakdown in water use data and the trajectory will, in future, assist in finding appropriate management solutions for the water requirements under future development.

Conclusions

Although the original focus of the project was on water boards, the report's results should be of interest to all people involved in water services delivery and water resources management. The emphasis in the project has been on quantifying the uncertainty in future predictions of available water resources and their quality.

The results emphasise the importance of considering both the uncertainties in climate and development together for appropriate management measures to be implemented. One of the critical recommendations for future water resources management that is of relevance to all catchments, and that was heard from various stakeholders involved in the project, has been the importance of integrated management and monitoring across various groups in the catchment. This integration is also critical in reducing the uncertainty in future predictions. Collaboration is the key to moving forward in order to meet the three aspired principles of the South African National Water Act: equity, sustainability and efficiency.

Further reading:
To obtain the report, *Informing the responses of water service delivery institutions to climate and development changes: A case study in the Amathole region, Eastern Cape* (**Report No. 2018/1/13**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.