POLICY BRIEF

June 2017
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.

WR2012 – Quantifying the water resources of South Africa

The recently-completed Surface Water Resources of South Africa, 2012 Study (WR2012) aims to assist decision-makers at all levels of government to make informed choices about all policies concerning South Africa's water resources. A significant feature of WR2012 is the fact that, for the first time, a publicly-accessible water resources website was created (www.waterresourceswr2012.co.za) which allows for Web-based and interactive reporting on both surface and groundwater.

Background

The WR2012 study is the sixth water resource assessment study to be undertaken in South Africa. The study, along with its predecessors, have played a major role in providing key hydrological information to water resource managers, planners, designers, researchers and decision-makers throughout South Arica.

Each water resource assessment study builds on the technology and knowledge gained from one that preceded it. The latest study, which covered South Africa, Lesotho and Swaziland, built on the previous assessment (WR2005) by using updated and new data and information as well as new tools and technology.

Knowledge of various new developments and an analysis of trends that have emerged in the water sector in the past five years guided the researchers in project implementation. The WR2012 study also took into account difficulties experienced by water resource users and, where possible, have made improvements.

The evaluation and improvement of existing tools, development of new tools and development of a website for 2012 [www.waterresourceswr2012.co.za] allows for national water resources planning which is more accurate and more efficient, and allows for easier updating in the future.

The emphasis in this study was in extending 'what if' capability developed in WR2005 to the user who would then be in the advantageous position of being able to generate his/her own information and GIS maps by combining information. The website greatly facilitates the rapid updating of data and availability of totally new information.

The naturalised mean annual runoff was determined as 49 251 million m^3/annum – virtually the same as the runoff calculated during the previous (WR2005) study.

GIS maps

Rainfall, runoff, water quality (in terms of total dissolved solids), WRSM/Pitman calibration parameters, land use and population maps have all been updated in the WR2012 study. GIS maps are available in hard copy and electronic format (from the website).

A statistical analysis was carried out on approximately 600 usable streamflow stations and the outcome was used to show six categories of streamflow gauging station on the map. This will help the user ascertain the quality of streamflow gauges and the reliability of data.

There is a totally new map based on the new present day analysis which analysed current levels of land use. Comparison were made against natural flow at 84 key locations throughout the country.

WRSM/Pitman model

The rainfall-runoff WRSM/Pitman model named after its innovator and developer, Dr Bill Pitman was a key part of this project and has underwent further enhancements during the study. Outputs from this model are used as the primary inputs to the Department of Water and Sanitation's water resources planning models.

The WRSM/Pitman monthly time-step model was used to analyse all catchments in South Africa, Lesotho and Swaziland with data up to September 2010. These networks

and data sets are included on the website for users to develop their own analyses.

A number of additional user-friendly features were added:

- Enhanced graphical tools for zooming, panning, log scale and data inspection
- Addition of the latest irrigation methodology
- Ability to calibrate the storage at a dam with observed and simulated storage trajectories
- Additional graphs for massplot and cusum plots for rainfall and naturalised streamflow
- Calibration of numerous runoff models in one step

Present-day analysis

The study made comparisons of naturalised streamflow versus present day streamflow at 84 key locations throughout South Africa. This provides an indication of the human influence on our river flows. While there are many return flows in the system, the study indicates that there are many catchments in South Africa that have outflows that are, on average, considerably lower than they would have been under naturalised conditions.

The previous water resources appraisals have shown a decreasing trend of the estimate of average naturalised mean annual runoff, but the WR2012 study has come out virtually the same as the previous one (WR2005).

Analysis shows the Vaal catchment to be the most heavily utilised, where the mean annual runoff (MAR) has been reduced by 66%, despite several transfers into the basin from the Lesotho Highlands, Thukela and Usuthu catchments. The least utilised catchment was found to be the Mzimvubu, where the MAR is reduced by only 8%.

Water quality analysis

During the WR2012 study, the simplified salt balance model SALMOD was analysed and calibrated for the entire Upper Vaal, Middle Vaal and Lower Vaal sub-water management areas (which have now been combined into the new Vaal WMA). This catchment is the most highly developed in South Africa with a great deal of land use/water use which impacts on water quality. Observed data was extended from 1974 to 2009. The final report provides data on flow, TDS concentration and TDS load at all the relevant water quality stations through the WMA.

Groundwater

Karim Sami compiled a comprehensive report on groundwater verification studies carried out in various parts of the country. Of particular interest was the updating of default groundwater parameters for every quaternary catchment (around 1 960) that are used in the Sami input screen of WRSM/Pitman.

Challenges and innovations

By far the biggest challenge of the study was the deterioration of data in the form of rainfall, observed streamflow, reservoir records (dam balances), land use/water use and water quality. Rainfall is the most important and shows the biggest decline in terms of rainfall stations which have closed down.

This deterioration of data makes it harder for hydrologists and water resources practitioners to enter data of the necessary quality into water resource models. These models produce hydrological information on streamflow, yields of dams, water quality trends, future demand versus supply trends, ecological water requirements etc.

Obviously, the accuracy of the above information will become compromised should this very distressing situation continue. Although the number of streamflow stations that is used in the appraisals since 1969 has increased with every appraisal, already 200 of the 600 have closed down. Their historical records were used, but no new data are becoming available.

Rainfall data is the most important data source for all water resources models. Raw rainfall data is of little use as it normally has some missing and unreliable months. The website contains all usable rainfall station data which has been patched. Similarly, observed streamflow data has also been patched up to September 2010.

In an attempt to address the decline in the ground-based observation networks and data quality, the WRC in partnership with DWS, DST, and data collecting agencies organized a number of workshops which culminated in the national Dialogue on hydrological data on 27-28 June 2016. Also attendance in the Dialogue were US agencies such as the USGS, USAID, US Embassy (Pretoria), etc who have taken interest in the climate-related data and weather extremes in sub-Saharan Africa.

The Dialogue recommended the establishment of a central repository for all hydrologically important data, and that this activity (i.e. establishment of the hydrology data centre) should become an activity of the bilateral between South Africa and the United States. Efforts are ongoing to define

the shape and form of such facility within the SA-US bilateral agreement.

The following reports have been published as part of this project:

- *WR2012 Executive Summary* (**Report No. TT 683/16**)
- *WR2012 User Guide* (**Report No. TT 684/16**)
- *WRC Book of Maps* (**Report No. TT 685/16**)
- *WR2012 Calibration Accuracy* (**Report No. TT 686/16**)
- *WR2012 SAMI Groundwater module: Verification studies, default parameters and calibration guide* (**Report No. TT 687/16**)
- *WR2012 SALMOD: Salinity modelling of the Upper Vaal, Middle Vaal and Lower Vaal sub-Water Management Areas (new Vaal Water Management Area)* (**Report No. TT 688/16**)
- *WRSM/Pitman User Manual* (**Report No. TT 689/16**)
- *WRSM/Pitman Theory Manual* (**Report No. TT 690/16**)
- *WRSM/Pitman Programmer's Code Manual* (**Report No. TT 691/16**)

To order any of these reports, contact Publications at Tel: (012) 761 9300,
or Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.