A wealth of new freely downloadable information on the water resources of South Africa, Swaziland and Lesotho

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BACKGROUND

The National Water Resources Strategy (2013) states: "For water to play an optimal role in poverty eradication, the reduction of inequality, inclusive growth and development, and building a just and equitable society, water resources planning must be integrated into national, provincial and local planning, and must be addressed in all growth and development strategies."

The WR2012, a ground-breaking water resources study, indeed provides a new and enhanced water resource analysis for South Africa, Lesotho and Swaziland. It is being funded by the Water Research Commission (WRC) and supported by the Department of Water and Sanitation (DWS).

Both authors, together with other key water resources experts, were tasked with developing the WR2012 study. Water resources appraisals have been the life work of both authors, who have collaborated in the building and enhancing of Professor Desmond Midgley and author Pitman's original work, dating back to the 1950s.

The WR2012 study started in 2012 and is due for completion in April 2016. Instead of waiting until finalising the whole study, work done up to date is posted on the website www.waterresourceswr2012.co.za.

AIMS AND OBJECTIVES

The aim was to build on the previous water resource appraisal of South Africa, Lesotho and Swaziland, which was called WR2005, by using updated data and information, and new tools and technology. This would increase the knowledge on water resources for planning purposes, and would make the knowledge more accessible through a website (Figure 1).

PROJECT DESCRIPTION

The rainfall-runoff WRSM2000/Pitman model, named after its innovator and developer Dr Bill Pitman, is a key part of this project, and has undergone further enhancements during this (WR2012) study. Outputs from the Pitman model are used

Figure 1: The WR2012 website (www.waterresourceswr2012.co.za)

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as the primary inputs to water resources planning models of the Department of Water and Sanitation. The WRSM2000/Pitman model is also popular for application in other African countries. The map in Figure 2 shows the African countries where the WRSM2000/Pitman model is known to have been used (Mauritius is also included but difficult to see).

This is the first appraisal in which the Pitman model was applied for the full time series since 1920 under present day water use conditions, to show what the runoff would have been if the land cover and water use had been for the whole period 1920–2010, as it is now. Comparing this with the naturalised flows, (the flows derived as if all catchments are still pris-

Figure 2: African countries where the WRSM2000/Pitman model has been used by Royal HaskoningDHV and Aurecon (in green)

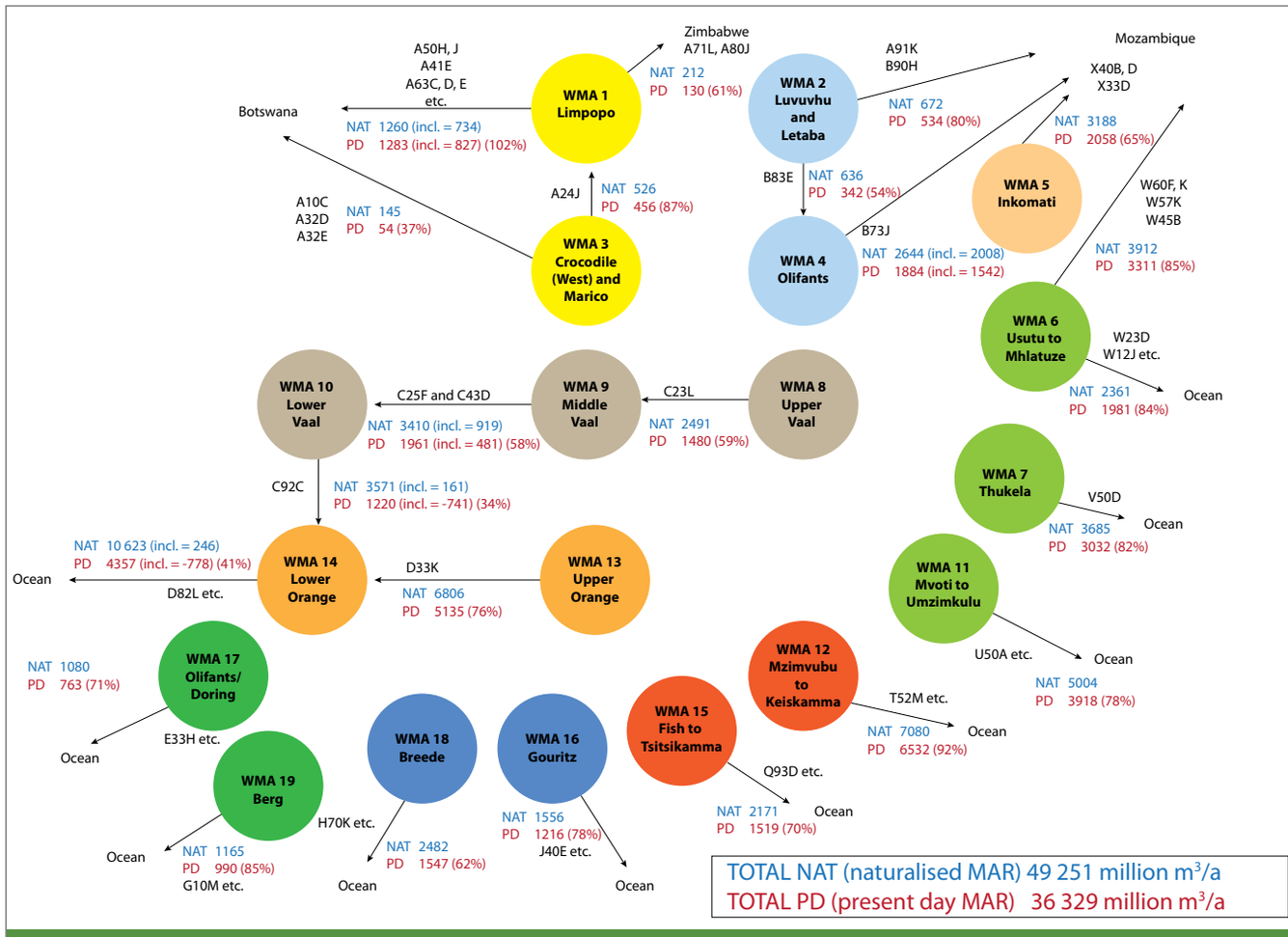

Figure 3: Present day (PD) versus naturalised streamflow (NAT) per WMA (circles are the old WMAs, circles of the same colours are combined in the new WMAs, NAT is averaged outflow under naturalised conditions, PD is averaged outflow under present day conditions, the % given is PD/NAT)

tine), gives an indication of the human influence on our river flows.

Figure 3 indicates that many catchments in the water management areas (WMA) 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 in the total of the estimate of average naturalised mean annual runoff (MAR). The WR2012 study has come out about the same as the previous one (WR2005). Figure 4 shows the change in mean annual naturalised runoff since 1952 of all outflows to the ocean or to other countries combined.

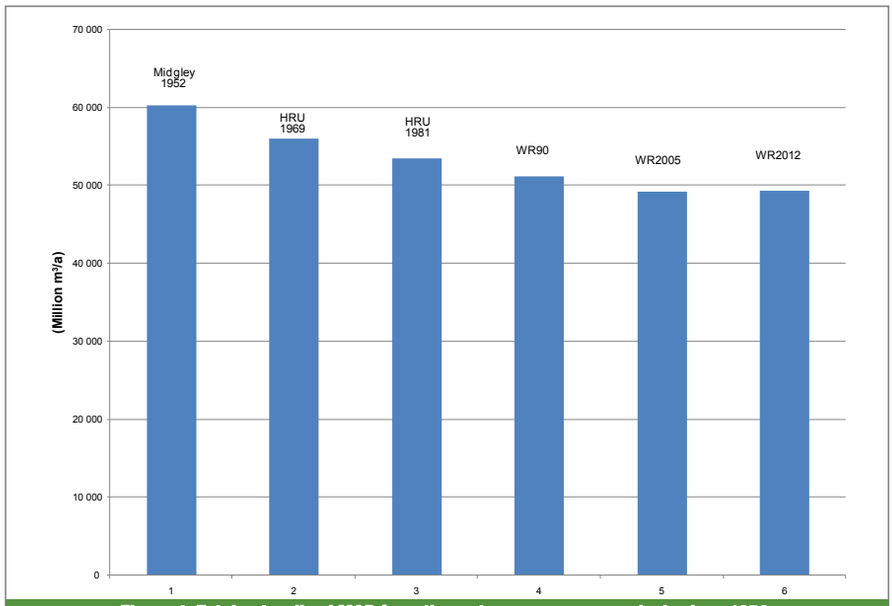

Figure 4: Total naturalised MAR from the water resources appraisals since 1952

PROBLEMS ENCOUNTERED AND INNOVATIONS

By far the biggest challenge was the deterioration of data in the form of rainfall, observed streamflow, reservoir records (dam balances), land cover/water use, water quality, etc. 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.

Figure 5 indicates that the number of streamflow stations used in the appraisals since 1969 have increased with

every appraisal. However, it is worrying that for the streamflow stations that were considered useful for the WR2012 study, already about 200 of the 600 have closed down. Their historical records were used, but no new data is becoming available.

Some innovative tools have been added to the WRSM2000/Pitman model to help overcome these data problems, such as the ability to calibrate not only on streamflow but also storage in dams. Use has been made of tools such as Google Earth to improve on the catchment detail.

To assist water resources professionals who do future studies, the flow gauging stations have been categorised as for their quality, and a database was maintained with remarks on the reason for putting them in a certain category. The gauging stations' quality is indicated in maps, as shown in Figure 6.

CONCLUSION

With about 75% of the study complete, and virtually all of the core water resources analysis complete, the key information for water resource planners is already available on the website (see box on page 17). In the last year of the study, the website will be supplemented with further deliverables and enhancements.

It is expected that the WR2012 website with all the GIS maps, WRSM2000/Pitman model with associated data sets, water quality models, reports, spread-

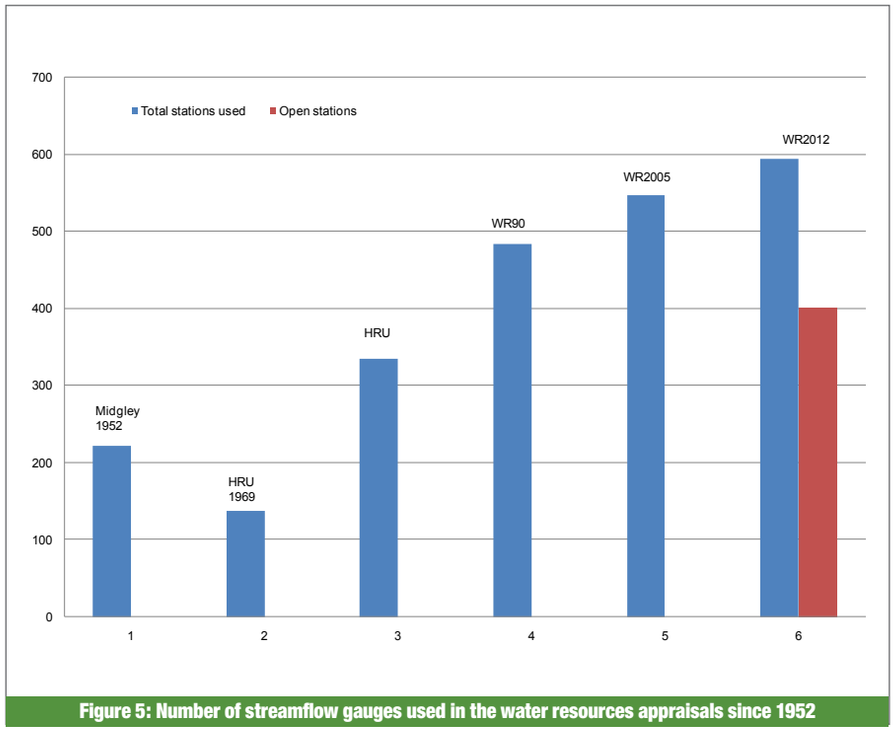

Figure 5: Number of streamflow gauges used in the water resources appraisals since 1952

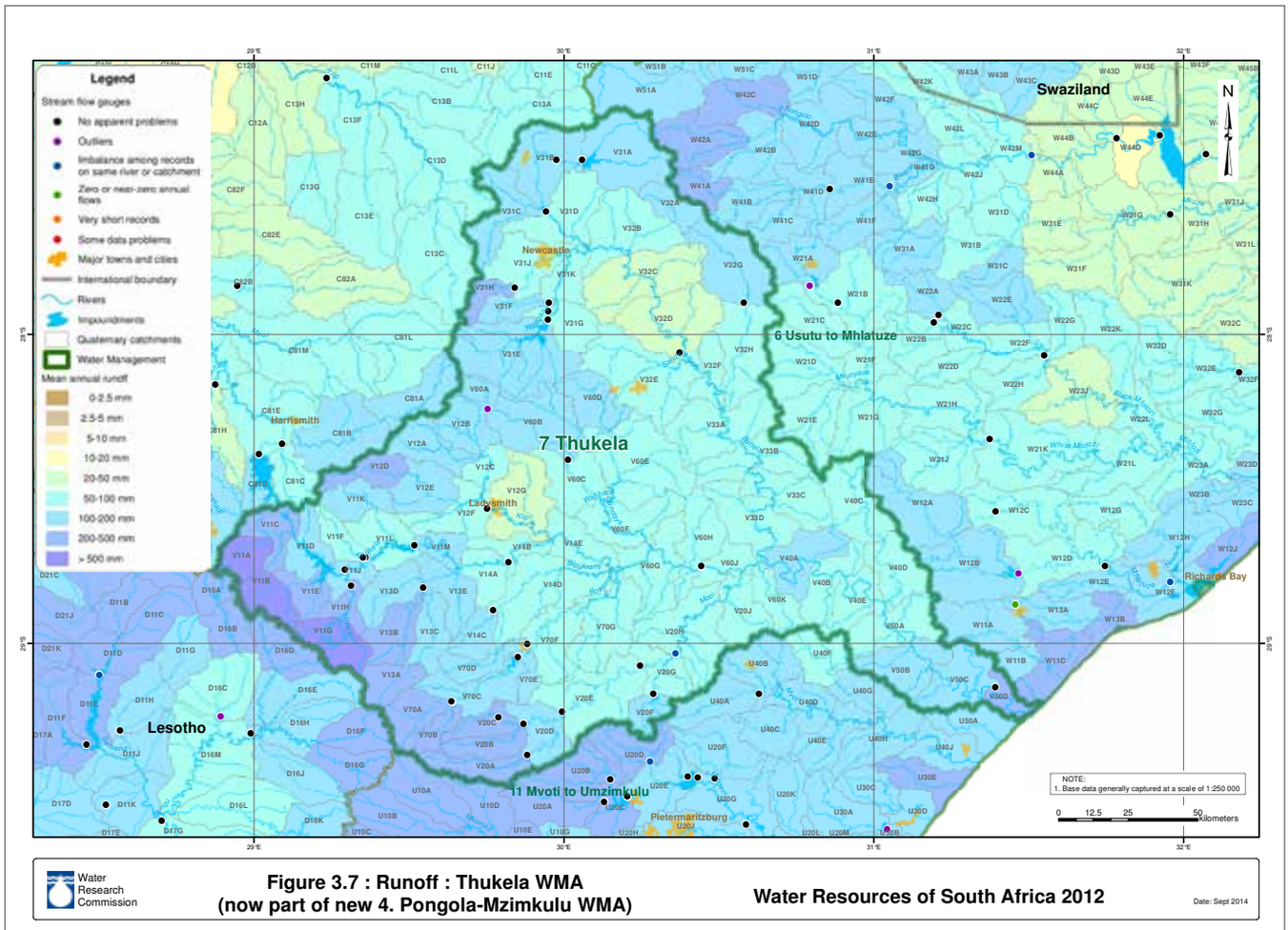

Figure 6: Example GIS map showing observed streamflow stations and their quality, as well as the mean annual runoff (mm/a) for all quaternary catchments

sheets, time series data, etc, will provide water resource planners with very valuable information, which will greatly facilitate their studies and would therefore be of great benefit to South Africa, Lesotho and Swaziland.

We recommend that all water professionals watch the website www.waterresourceswr2012.co.za over the coming year, as more deliverables will be added that are still being completed as follows:

- WR2012 Executive Summary and Users Guide.
- Map book of 77 GIS maps with background, rainfall and runoff maps for each water management area (WMA), and other relevant maps for South Africa, Lesotho and Swaziland. The previous WR2005 study GIS maps are currently on the website and are to be updated for WR2012. They are in hard copy and electronic format, and cover numerous water resources issues, such as rainfall, streamflow, evaporation, land cover, WRSM2000 calibration parameters,

WR2012 DELIVERABLES ALREADY AVAILABLE

Already complete and available on the WR2012 website are the following:

- WRSM2000/Pitman model (monthly time step) including the latest data sets, network diagrams, etc, for South Africa, Lesotho and Swaziland.
- Rainfall – individual rainfall station patched data up to September 2010, catchment rainfall groups and catchment rainfall.
- Observed patched streamflow up to September 2010.
- Naturalised modelled streamflow from 1920 up to September 2010.
- Monitoring information on rainfall, observed streamflow and water quality with recommendations for improvement up to a minimum desired state.
- Natural and present day streamflow analysis per quaternary catchment. WRSM2000/Pitman data sets at present day levels of development are available. Natural and present day streamflow have also been summated and analysed on a water management area (WMA) basis.
- Land cover/water use spreadsheets with information on dams, abstractions and return flows, irrigation, alien vegetation and afforestation.
- Daily time step in WRSM2000/Pitman model for naturalised streamflow, as well as catchment analysis including land cover/water use.
- Water quality analysis of a number of water quality parameters per quaternary catchment.
- WRSM2000/Pitman model, the previous WR2005 study reports and a water quality report.
- WR2012 Sami groundwater report.
- All available reservoir records.

geology, soils, sediment, vegetation, ecological water requirement management classes, water quality in terms of total dissolved solids (TDS) and population. The electronic maps are in ArcView with zoom, search and other standard tools.

- Statistical analysis of about 600 streamflow gauges and reports. This analysis was used to assign each streamflow station to one of six categories which have been shown on GIS maps as different colour dots.
- Enhanced WRSM2000/Pitman model with daily time step, and a number of improved graphics such as graphics enhancement, calibration on storage, multiple runoff module calibration, additional graphs on streamflow and rainfall, new irrigation methodology, etc.
- Quaternary data spreadsheets. The previous WR2005 spreadsheets are being updated with WR2012 data for catchment areas, rainfall, evaporation, naturalised streamflow, Pitman calibration parameters and Sami groundwater default data.
- Salinity modelling of the entire Vaal River, i.e. the entire new Vaal WMA, showing graphs and tabular information for TDS.

Training in the use of the models and the website data can be provided on request.

ACKNOWLEDGEMENTS

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With about 75% of the study complete, and virtually all of the core water resources analysis complete, the key information for water resource planners is already available on the website. In the last year of the study, the website will be supplemented with further deliverables and enhancements.

LAUNCH OF THE WR2012 WEBSITE

The WR2012 website was demonstrated to an audience of water professionals by Dr Bill Pitman and Allan Bailey at its launch on 19 March 2015 in Centurion. Amongst the audience at the much anticipated launch were personnel from the WRC and DWS Client Group, private sector consultants in the natural sciences (hydrologists, wetland specialists, soil scientists and ecologists), engineers and urban and regional planners.

Presenters at the launch of WR2012 (from left): Allan Bailey (project leader for Royal HaskoningDHV), Dr Ronnie Mckenzie (keynote speaker for WRP Engineers), Dr Bill Pitman (key team member for Royal HaskoningDHV and developer of the WRSM2000/Pitman model), Wandile Nomquphu (Water Research Commission project manager), Deborah Mochotlhi (Deputy Director General DWS) and Prof Geoff Pegram (Emeritus Professor University of Kwazulu-Natal, project leader WRC project on mapping mean annual precipitation)

WR2012 Project Team members (from left): Sarah Collinge and Allan Bailey (Royal HaskoningDHV), Tobias Göbel (GTIS), Dr Bill Pitman (consultant to Royal HaskoningDHV), Karim Sami (WSM-Leshika), Kerry Grimmer (Mott McDonald PDNA), Dr Marieke de Groen and Saieshni Thantony (Royal HaskoningDHV)

WRC and DWS Client Group (from left): Eiman Karar (Executive Manager Water Resources Management, Water Research Commission), Dhesigen Naidoo (CEO Water Research Commission), Wandile Nomquphu (Water Research Commission project manager) and Deborah Mochotlhi (Deputy Director General DWS)