

IUGG QUADRENNIAL REPORT 2003 to 2006

South African Committee for the International Association of Hydrological Sciences

1. MEMBERS OF THE COMMITTEE

The current committee was appointed after a call for nominations during 2004 resulted in no response from the members of SANCIAHS and the composition of the committee was re-visited during the 12th National Hydrology Symposium in September 2005. At that symposium it was agreed that the membership of the committee would remain the same until new elections are held at the planned 2007 National Hydrology Symposium in the Western Cape.

The national committee for 2004 consisted of the following:

Dr P Ashton, CSIR (Vice-President, IAHS Int. Commission for Water Quality)

Dr J Boroto, Global Water Partnership, Harare, Zimbabwe

Mr R Dube, Water Research Commission

Prof. DA Hughes (Chairman and National Representative, Vice-President, IAHS Int. Comm. for Surface Water), Rhodes University

Dr G Jewitt, University of KwaZulu-Natal, Pietermaritzburg

Mr W Kamish, Ninham Shand Consulting Engineers

Dr S Lorentz, University of KwaZulu-Natal, Pietermaritzburg (Vice-President, IAHS Int. Comm. for Tracers).

Dr J Ndiritu, University of the Witwatersrand

Mr R Parsons, Consultant Geohydrologist

Prof. RE Schulze, University of KwaZulu-Natal, Pietermaritzburg

2. RESEARCH CONTRIBUTIONS

There remains a strong emphasis in hydrological and water resources research on supporting the National Water Act (NWA, 1998) of 1998 and the implementation of the water resource management strategy for South Africa. Part of this research is focused on addressing previous imbalances in access to clean water, while work is also being undertaken on establishing improved institutional management systems at different levels (from communities through to national agencies). Figure 1 illustrates the balance of research funding using information contained within the Water Research Commission (WRC - the main funding body supporting water resource and hydrological research within South Africa) annual report for 2005/06 on new projects started during 2005. Water resource assessment and water supply and treatment technology clearly remain high priority areas. However, it is interesting to note that the funding for projects focused on water use for poverty reduction (and wealth creation) ranks third overall. While the ongoing diversification of water related research in South Africa has meant that more institutions are supported by research funding, the majority of mainstream hydrological sciences research is still undertaken at a few university departments and civil engineering consulting companies. Unfortunately, it is apparent that there are also fewer young hydrological scientists joining the community, which is of great concern for the future sustainability of scientific water research in South Africa.

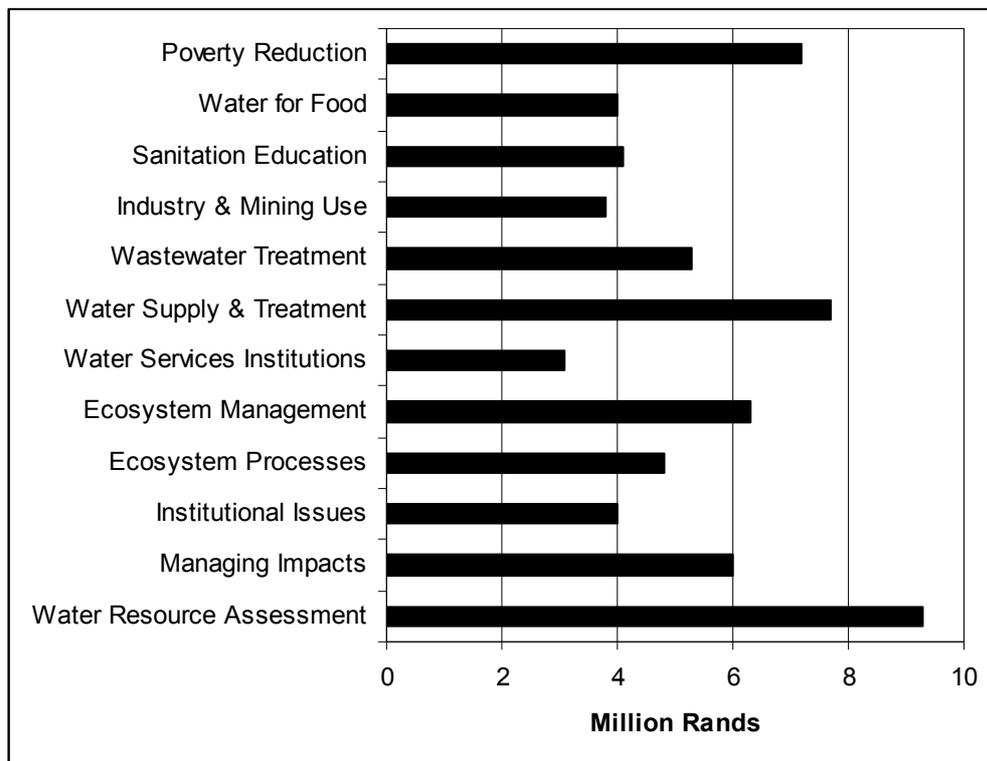


Figure 1 Water Research Commission funding: Projects identified in the Annual Report for 2005/06

A further indication of the type of research being undertaken within South Africa can be based on the subject matter of the papers presented at the biennial SANCIAHS National Hydrology Symposium. The 2005 symposium contained a wide mix of papers that covered hydrological process studies, model development and application in both hydrology and water resources, remote sensing applications in hydrology, water quality, climate change issues, as well as water management and policy. It is interesting to note that there was a reasonable balance between development research and the application of hydrological and water resource analysis techniques in practice. This suggests that the current state of hydrological research within South Africa is healthy and that the long tradition of applied research is continuing.

The following sections highlight some of the research directions that have been dominant in the hydrological sciences within South Africa during the reporting period, while the 'Selected References' section illustrates some recent outputs in international journals, the 2005 SANCIAHS conference and WRC scientific reports. Further information about past, current and future research programmes supported by the WRC can be found at their web site, which also includes lists of publications (<http://www.wrc.org.za>).

2.1 Hydrology and the ecological Reserve

The ecological Reserve is the South African terminology for the water quantity and quality requirements of aquatic ecosystems (rivers, wetlands, ground water and estuaries) that are 'reserved' under the NWA for the purposes of sustaining the environment in a pre-determined

condition. A great deal of research in the past has contributed to the refinement of the methods that are used to quantify these requirements. During the reporting period major contributions were made to the methods of assessment for ground water systems (Xu et al., 2003), hydraulics issues related to Reserve determinations (Jordanova et al., 2004), water quality methods (Palmer et al., 2004) and scenario-based methods (King et al., 2004). Many of the existing methods of assessment and data analysis have been incorporated into an integrated package based on spatial data visualization and database management tools (Hughes, 2004a).

New WRC projects started during the reporting period and yet to be finalized include assessments of wetland integrity, development of real-time Reserve implementation methods (Hughes, 2004b) and environmental water requirements of ephemeral river systems (Hughes, 2005). There are further initiatives supported by the Department of Water Affairs and Forestry that are designed to improve the application of existing methods and enhance the capacity of water managers to implement the policies of the NWA.

2.2 Ground and surface water interactions

The previous SANCIAS report (2000-2003) referred to the divide that has existed between the two disciplines of ground and surface water hydrology. With the emphasis on integrated water resource management there has been some progress in bringing the two disciplines together. As part of the development of the widely used Pitman monthly model, Hughes (2004c) incorporated some simple ground water routines that allow the interactions between surface and ground water to be simulated at the catchment scale. While not designed as a substitute for more complex ground water investigation tools, the changes have proved useful particularly with respect to assessing ground water contributions to streamflow. Similar algorithms have been built into a commonly used water resource systems model so that yields from both sources can be simulated in an integrated manner. One of the critical issues in any model involving ground water is the accurate estimation of recharge and its variability. Meyer (2005) analysed the limited ground water level data available in the country and related it to patterns of rainfall variation.

Process studies in selected catchments contribute a great deal to our understanding of the interactions between surface and ground water, while isotopic tracer studies (Talma and Lorentz, 2005) appear to have a great deal of potential but have not been used extensively in South Africa.

Many rural areas of South Africa rely on ground water supplies for domestic water and small scale irrigation. At the same time the occurrence of ground water in the fractured rock systems of the country is frequently complex and difficult to accurately assess. A project started in 2005 is designed to improve our understanding of the occurrence and dynamics of these aquifers.

2.3 Rainfall-runoff modelling

South Africa has a long history of developing and, more specifically, the practical application of rainfall-runoff models for water resource estimation purposes. Both hydrological (rainfall-runoff) and water resource system models are used frequently for planning and operational management purposes. While there have been recent developments to the structures of some models used within South Africa, a greater emphasis has been placed on the practical application of the models through the development of user-friendly and data efficient interfaces and the use of the models in ungauged situations (parameter estimation and regionalization of parameter sets). One current WRC project (referred to as WR2005, see Bailey and Pitman,

2005) involves updating the national surface water database through the use of a revised version of the Pitman monthly model and the generation of natural simulated time series for all 1946 so-called quaternary catchments. The project will provide a GIS and database interface to the raw data, as well as facilities to run the model for any future development scenario. Another project is designed to develop a hydrological decision support framework (Clark and Smithers, 2005) based on the SPATSIM modeling system (Hughes, 2004a) but incorporating new database design, the ACRU daily hydrological model and the principles of OpenMI to facilitate the linking of models or sub-models.

Additional modeling research, often through postgraduate student projects, involves regional parameter estimation, the identification and reduction of uncertainty in the results of hydrological models.

2.4 Landuse impacts on hydrology and evapotranspiration research

The assessment of the impact of various landuse practices on streamflow remains a focus area in hydrological research. Some of this research overlaps with the rainfall-runoff modeling theme and the ACRU daily model has been used to regionalize the impact of different types of afforestation on streamflow, with a special emphasis on low flows (Blight et al., 2005). Additional research is being undertaken on the effects of riparian vegetation management on water resources.

One of the critical issues associated with understanding landuse change impacts on hydrology is the effects on evapotranspiration loss dynamics. There are several active research projects designed to improve our understanding of the consumptive use of water by vegetation. Some of these involve field observations and monitoring networks (Savage et al., 2005), while others focus on improving estimation techniques.

2.5 Design rainfall and flood estimation

Projects directly associated with improving flood estimation techniques include the use of continuous simulation models (Smithers and Chetty, 2005) and updating the guidelines for design flood estimation for the purposes of dam safety. Other work on the use of radar data for space-time rainfall analysis is continuing (Sinclair and Pegram, 2005).

2.6 Satellite applications in hydrology

Although frequently used internationally, the estimation of soil moisture and rainfall data using satellite derived information has not been applied extensively in southern Africa. Through international cooperation a new project has been launched on the use of remote sensing to estimate soil moisture for various hydrological applications (Nxumalo and Pegram, 2005). Recent research has also focussed on the use of satellite rainfall data (Hughes, 2006a and b) as input to hydrological models in the face of declining ground-based observation networks.

2.7 Climate change research

No report on hydrological research would be complete without some mention of the contribution of South Africa to assessments of the impacts of global climate change. Apart from climatology research on regional climate atmospheric models, the WRC are also supporting several projects

on predicting the effects on water resources and secondary effects (water quality, such as nutrient recycling and temperature), as well as using a knowledge of climate variability to support water resource management. Some of these research programmes overlap with themes already referred to such as rainfall-runoff modeling (Lumsden and Schulze, 2005).

3. CONFERENCES and SYMPOSIA

The **12th National Hydrology Symposium** was held at the ESKOM Convention Centre, Midrand, Gauteng during September 2005. The conference was well supported by researchers, as well as water resource practitioners from government departments and private consultancy companies. The Water Research Commission sponsored awards for the three best papers and this prompted the SANCIAHS committee to propose an award for the best student paper at the next symposium in 2007. The full papers presented at the conference are available on CD.

The **13th National Hydrology Symposium** is scheduled to be held in Cape Town during September 2007.

There have been a number of additional water related conferences held in South Africa during the reporting period. Many of these are expensive commercial conferences related to various aspects of water legislation and water resource management.

4. INTERNATIONAL AND REGIONAL COOPERATION

Apart from links between various individual organizations in South Africa and others throughout the world, South African hydrological scientists are actively engaged in a number of international research programmes including IAHS PUB (prediction in ungauged basins) and the UNESCO HELP (Hydrology for the Environment, Life and Policy) and FRIEND (Flow Regimes from International Experimental and Network Data) initiatives.

5. SELECTED PUBLICATIONS

Bailey, AK & Pitman, WV (2005) **The Water Resources 2005 Project (WR2005)**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.

Blight, JJ, Gush, MB, Le Maitre, D & Jewitt, GPW (2005) **The impacts of afforestation on low flows: Paired catchments revisited**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.

Clark, DJ & Smithers, JC (2005) **Hydrological decision support framework – initial design**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.

Hughes, DA (Ed) (2004a) **SPATSIM, an integrating framework for ecological Reserve determination and implementation**. Water Research Commission Report No. TT 245/04.

Hughes, DA (2004b) **Real time operation of environmental flows in South Africa**. Poster and verbal presentation at the British Hydrological Society International Conference, Imperial College, London, July 2004.

Hughes, DA (2004c) Incorporating ground water recharge and discharge functions into an existing monthly rainfall-runoff model. **Hydrol. Sci. Journ.** 49(2), 297-311.

- Hughes, DA (2005) Hydrological issues associated with the determination of environmental water requirements of ephemeral rivers. **River Research and Applications**, **21(8)**, 899-908.
- Hughes, DA (2006a) Comparison of satellite rainfall data with observations from gauging station networks. **Journ. Hydrology**, 327(3-4), 399-410.
- Hughes DA (2006b) An evaluation of the potential use of satellite rainfall data for input to water resource estimation models in southern Africa. **Climate Variability and Change – Hydrological Impacts** (Proceedings of the Fifth FRIEND World Conference held at Havana, Cuba, November 2006), **IAHS Publ. 308**, 75-80.
- Jordanova, AA, Birkhead, AL, James, CS & Kleynhans, CJ (2004) **Hydraulics for determination of the ecological Reserve for rivers**. WRC Report No. 1174/1/04. Water Research Commission, Pretoria, South Africa.
- King, JM, Brown, CA, Paxton, BR & February, RJ (2004) **Development of DRIFT, a scenario-based methodology for environmental flow assessments**. WRC Report No. 1159/1/04. Water Research Commission, Pretoria, South Africa.
- Lumsden, TG & Schulze, RE (2005) **Challenges associated with assessing the impacts of climate change on water resources in South Africa**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Meyer, R (2005) **Analysis of groundwater level time series and the relation to rainfall and recharge**. WRC Report No. 1108/1/04. Water Research Commission, Pretoria, South Africa.
- NWA (1998) **National Water Act of South Africa**. Act 36 of 1998. Government Printer, Pretoria, 50pp
- Nxumalo, NT & Pegram, GGS (2005) **Soil moisture from satellites**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Palmer, CG, Scherman, P-A, Muller, WJ, Rossouw, JN, Malan, HL & Jooste, S (2004) **Early development of water quality methods and approaches in ecological Reserve assessments**. WRC Report No. 1108/1/04. Water Research Commission, Pretoria, South Africa.
- Savage, MJ, Odhiambo, GO, Mengistu, MG, Everson, CS & Jarman, C (2005) **Theory and practice of evaporation measurement, with special focus on surface layer scintillometry as an operational tool for the estimations of spatially-averaged evaporation**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Sinclair, S & Pegram, GGS (2005) **Empirical mode decomposition in 2-D space and time: A tool for space-time rainfall analysis and nowcasting**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Smithers, JC & Chetty, KC (2005) **Design flood estimation using a continuous simulation modelling approach**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Talma, S & Lorentz, S (2005) **Isotopic composition of runoff in large catchments in southern Africa**. Paper presented at the 12th South African National Hydrology Symposium, Midrand, September 2005.
- Xu, Y, Colvin, C, van Tonder, GJ, Hughes, S, le Maitre, D, Zhang, J, Mafanya, T & Braune, E (2003) **Towards the resource directed measures: groundwater component**. WRC Report No. 1090-2/1/03. Water Research Commission, Pretoria, South Africa.