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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.

TECHNICAL BRIEF

Water resources management

Water resources of South Africa 2005 study

The findings of the latest Water Resources Study (WR2005) are now available from the WRC.

From WR90 to WR2005

The need to update the widely used and highly valued 1990 study on Surface Water Resources of South Africa (WR90) resulted in a follow-up study, called the Water Resources of South Africa 2005 Study (WR2005), being commissioned in 2004.

WR90 and its predecessors had played a major role in providing key hydrological information to water resource managers, planners, designers, researchers and decision-makers throughout South Africa since the late sixties. The 1990 study had generated a vast amount of information at quaternary catchment level for the whole of South Africa, Lesotho and Swaziland. The information covered dams, evaporation, geology, land cover, rainfall, recorded and simulated runoff, rivers, sediment yield, soils, settlement locations and vegetation types.

WR90 relied greatly on adding value to observed data through catchment simulations with the WRSM90 computer model. The products generated from the WR90 project (databases, information and modelling tools) became an essential resource for water resources management, planning, operations and research. Products were used by decision-makers, practitioners, consultants and researchers in organisations ranging across national government, engineering consulting firms, universities and research organisations.

Ultimately, the WR90 user group was no longer confined to the water sector, having grown to also include users from, for example, the agricultural, energy, industrial and municipal sectors.

The WR90 time series data stretched from 1920 to 1989, making the data relatively outdated by the turn of the century. Extending the WR90 datasets within the context of the new (2005) study had become necessary for the following purposes:

- To capture the worst drought period on record since the 1920s, which occurred during the 1990s.
- To benefit from improved land use modelling techniques and more reliable methods of estimating water use by various sectors and stream flow reduction activities.
- To take into account changes in national legislation (National Water Act of 1998) which placed a different emphasis on how water is governed and allocated, particularly with regard to basic human needs, ecological water requirements and international commitments.
- To make use of major improvements in software development and information technology since the 1990s.

A new focus

The focus of the new WR2005 study was to be on investigating water resources from an integrated perspective, in line with the objectives of integrated catchment management enshrined in the National Water Resources Strategy. The aim was not merely to produce a simple update of WR90 information, but to re-evaluate, improve and, where necessary, redevelop the tools to be applied in WR2005.

Knowledge of various new developments and an analysis of trends that had emerged in the water sector in

the past decade would provide further direction for the study. Special account was to be taken of the needs of Catchment Management Agencies (CMAs), given that CMAs would be taking responsibility for future water resources planning and management in their areas.

The WR2005 study results would thus aim to represent the historical and present state of water resources and also allow for the better representation of a number of future water resources scenarios at the quaternary catchment level.

Enhancements

The 2002 version of the WRSM2000 model (an improvement on the WRSM90 model used in the WR90 study) was chosen as a departure point for the WR2005 study. Being essentially a surface water model, it was necessary to incorporate certain enhanced methodologies into WRSM2000 in order to satisfy the requirements of WR2005.

One such enhancement was introduced to provide WR2005 with greater capability in dealing with issues of groundwater and groundwater-surface water interactions, given the simplistic manner in which groundwater had originally been treated in WRSM2000. This enhancement entailed implementing two additional methods (those of Hughes and Sami) for dealing with groundwater far more extensively and in greater detail than before. Although these two methodologies differ significantly in several respects, they give similar results.

Apart from groundwater, other major enhancements to WRSM2000 have focused on better ways of handling irrigation and irrigation return flows, the exchanges of water that take place between the river channel and neighbouring wetlands, the characterisation and impacts of streamflow reduction areas within a catchment, water usage due to afforestation and alien vegetation, the hydrological impacts of dryland crop production and water quantity issues associated with various mining activities.

The final WRSM2000 product is interfaced to the Hughes SPATSIM 'umbrella system'. This provides WR2005 with access not only to WRSM2000, but also to a number of models in the SPATSIM system and, furthermore, provides WR2005 with a powerful spatial (mapping) dimension. The Hughes SPATSIM system, used for this purpose, is a version that was especially customised for the WR2005 study.

The customised WR2005 SPATSIM system basically consists of a GIS Viewer, a database and a framework of models which interact with the database and the spatial applications. The GIS Viewer, taken from the Hughes SPATSIM system, is automatically invoked when executing WR2005 SPATSIM.

Whereas initially the WRSM2000 model only read data from, or wrote it to, text files, the development of the WR2005 database has now made it possible to reading data from and writing it to the database and to perform database functions. All information pertaining to the WRSM2000 networks and associated data, coverage and maps are also stored on the WR2005 database, the structure of which has been fully documented.

WR2005 SPATSIM gives the user the option of running a number of programs and models. The key models are the enhanced WRSM2000 model, SALMOD, the Hughes Desktop Reserve Model and the Stress/Flow and Risk Indicator Model.

The model SALMOD is one of two software programs (developed by Herold as a separate activity) that WR2005 uses to analyse water quality data for the entire country. While SALMOD undertakes simplified salinity modelling, the second program, named OTHER, does a spreadsheet analysis.

Two ecological models that have been included in the WR2005 version of SPATSIM are the Hughes Desktop Reserve Model (DRM) and the O'Keefe ***et al*** Stress/Flow and Risk Indicator Model (STRESSOR). These models deal with surface water ecosystems and do not cover groundwater or wetlands. The use of the DRM model offers a simple low confidence analysis of Ecological Water Requirements (EWRs), whereas including the STRESSOR model in the analysis allows for more detail and also for graphical depiction of stress effects on the environment.

Running WR2005

The installation and use of WR2005 software enables the user, among other things, to:

- Run any model in the WR2005 SPATSIM system
- View GIS coverages which can be overlaid, zoomed into, have information added and printed

- Inspect data associated with points or catchment areas
- Inspect naturalised flows for any quaternary catchment
- Set up EWR nodes and determine EWR time series
- View WR2005 GIS pre-defined maps which consist of a number of GIS coverages which can be switched on or off
- View the WR2005 database including the WRSM2000 hydrological information and network diagrams.

WR2005 products

The map books and appendices produced in the WR90 study have not been re-produced in the WR2005 study. These WR90 reports still provide a great deal of useful information, and should be used in conjunction with WR2005. The emphasis in WR2005 has been on transferring 'what if?' modelling capability to the user who would then be in the more advantageous position of being able to generate his/her own information and maps from data in the database.

The main product of the WR2005 study is a DVD containing, among others:

- The models used in the study (Enhanced WRSM2000; OTHER; WR2005 SPATSIM with DRM, STRESSOR and SALMOD)
- The WR2005 User's Guide
- Book of Maps
- The WR2005 database containing WRSM2000 data
- Spreadsheet information by quarternary catchment, and
- Various GIS maps.

Owing to demand, a hard copy version of the full Book of Maps was also produced. It includes the base maps for water management areas, as well as maps for rainfall, evaporation, runoff, landcover, interbasin transfers, geology, soils, sediment, vegetation, EWR Management Class, surface water quality (TDS), population density and groundwater exploitation potential.

Keeping WR 2005 up to date

WR2005 represents the first country-wide water resources survey to have included surface water, groundwater and water quality components. It is more than likely that information, knowledge and techniques needed to deal optimally with these components and their integration will improve with time.

In addition, there are bound to be advances in computer platforms, programs and methodologies, all of which could and should, in due course, be exploited to bring about major improvements in future assessments of the water resources of South Africa.

Already there are examples of recent developments, which could be potentially beneficial for future enhancements of WR2005. One example is a revised set of groundwater parameters for the entire country that could make enhanced groundwater assessments possible. Another is newly developed code for a WRSM2000 visualiser, which, if included, would make it a great deal easier for users to have consistency between their WRSM2000 network diagrams and the actual data in their WRSM2000 datafiles. At present, such lack of consistency is a major source of potential error and inefficiency.

Changes within a catchment will require certain adjustments to WR2005 components. For instance, new infrastructural development, such the recent Berg River Dam development, will make it advisable to update WRSM2000 networks and associated data files. Likewise, changes to the rain gauge and streamflow networks over time could result in gaps in geographical coverage which would need to be appropriately addressed.

Further reading:
To obtain the report, *Water Resources of South Africa 2005 User's Guide (Executive Summary)* (**Report No TT 380/08**), *User's Guide* (**Report No: TT 381/08**) or the *Book of Maps* (**Report No: TT 382/08**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or E-mail: orders@wrc.org.za.