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TECHNICAL BRIEF

Agricultural water management

This study explored the effectiveness of technology exchange through the integrated implementation of selected applicable modelling tools.

Meeting complex water management challenges in commercial agriculture

According to the National Water Resource Strategy, the commercial irrigation sector is responsible for over 62% of South Africa's total water use. The 1998 National Water Act calls for water to be used in an equitable, efficient and sustainable manner.

Appropriate decision support is required by the irrigation sector if the challenging objectives of this Act are to be adequately met. Over a number of years, several models catering for specific aspects of water resource management have been developed with funding from the WRC.

Projects designed to transfer modelling technologies to users have been undertaken in the case of each of the models. However, use of models on an individual basis provides only partial support when addressing invariably complex management situations. It would be much better to employ an appropriate suite of models that permit the solutions generated to be more holistic and optimal for the management challenges encountered.

With this in mind, integrated implementation of potentially applicable models has been piloted in a collaborative project with five water user associations (WUAs) and two irrigation boards (IBs) across South Africa.

Potentially applicable modelling tools

ACRU

This is an integrated agrohydrological modelling system capable of being used, among others, for water resource assessments, design flood estimations, crop yield assessments and irrigation water demand and supply evaluations. However, since ACRU cannot as yet accommodate complex catchment operating rules, it was used, in the context of this project, primarily as a catchment-scale, daily time-step hydrological rainfall-runoff model to provide estimates of streamflow from non-irrigated lands needed as input into the MIKE BASIN model (unlike the other listed models, not of South African but of Danish origin). MIKE BASIN was used to simulate the supply and demand interactions and, specifically, to deal with the catchment's irrigated lands, these being subject to operating rules that are easily represented in MIKE BASIN.

WAS

This is a modelling system that promotes efficient operational management of water. WAS consists of four main modules that can be implemented either jointly or independently, depending on the requirements of the specific application. The modules are:

- The Water Administration module, which administers the details of all water users, including addresses, scheduled areas, water quota allocations, crops planted, planted areas and crop yields;
- The Water Orders module, which administers water usage, including the capturing of water orders and the provision of water allocation, water balance and water usage reports per user;
- The Water Release module, which links with the Water Orders module and calculates water releases for the main canal or river and all its branches and tributaries, allowing for lag times and any water losses and accruals; and
- The Water Accounts module, which links with the Water Orders module and administers all water accounts for a scheme or water management office.

SAPWAT

This is a crop water use planning model that can be applied at field or scheme scales. A supporting database allows it to be used to estimate the crop water use requirements of different crops under different irrigation systems and different irrigation management regimes throughout South Africa and neighbouring countries.

SWB

Originally a generic, mechanistic model for real-time irrigation scheduling at field scale, this model has been further developed (and renamed SWB-Pro) to allow its use for planning purposes.

RISKMAN

This is a simulation model of net cashflow for water use and crop combinations at specified risk levels, generally applied at farm scale.

Participating WUAs and IBs

Those WUAs and IBs which participated in the project, did so by virtue of their strong need to use the respective models as well as their commitment to collaborate in model implementation and their possession of the level of infrastructure required for successful participation. The further hope was for these participants to develop into centres of expertise that would, in time, be able to provide leadership and knowledge to other WUAs and IBs with similar requirements

Approach to the project

The selected models, like all models, are driven by input data, which are then transformed into useful information via computations that simulate various natural and management processes. A central approach to this project was, therefore, first to capture high-quality data pertaining to each of the participating WUAs and IBs in a Geographic Information System (GIS).

This step in itself was of great interest and value, allowing stakeholders to view and better understand the spatial and temporal context of key information. The data incorporated into the GIS system were then used (with other input data) to drive the models associated with the project.

Originally, it had been intended to develop a unified database, from which all models would draw their input data and to which their output data could be written. However, with the GIS in place, the complex task of developing a unified database would not have added enough value to justify its further undertaking.

Following several rounds of consultation between researchers and end-users, the appropriate model and model combinations were configured and technology transferred to the participating WUAs and IBs. User manuals were prepared. In addition, training courses were held for the respective models and for the GIS.

Finally, a significant amount of work was done to ensure that models could be used sustainably over time. In this regard, a focus was on re-developing models to better integrate with one another and to facilitate use by consultants, who would then be in a better position to service the growing need for modelling support. Where model development had previously taken place in an academic environment, objectives of a scientific nature had generally taken precedence over the need to package software for cost-effective use by practitioners.

Key findings and conclusions

The GIS component of the project has, apart from the purpose of providing a support base for model implementation, proved to be most useful to WUAs and IBs as a source of information for general planning and operational purposes. For example, the GIS imagery facilitates management and maintenance of irrigation canal systems and enables crop types and cropping areas to be verified with confidence, without the WUA or IB having to request this information from individual water users.

Modelling technology has been successfully transferred to participating WUAs and IBs, which is indicative of the sustained interest in, and value of, the respective models. Over and above changes made to facilitate integration and use by practitioners, further updating of the model has taken place in response to valuable feedback received from the participating WUAs and IBs. This will further promote the sustained use of the models after the completion of the project.

User needs for the models vary. WAS and SAPWAT are either already in use, or will be coming into use in the very near future. The demand for the other models is anticipated to grow significantly once the compulsory licensing process has been completed, especially in catchments where water resources have been over-allocated. Models such as SWB and RISKMAN will be very useful for testing the hydro-economic impacts of various water-use and land-use scenarios. Likewise, the ACRU-MIKE BASIN model combination is well suited to assisting resource managers in evaluating different water management options.

Recommendations

1 **Further model development:**
   - Incorporation of RISKMAN into ACRU-MIKE BASIN will bring an essential economic component to the model combination. This will enable water resource managers to assess the hydro-economic impacts of various operating rules and license allocation decisions on water users, particularly in over-allocated catchments.
   - Further development of the SWB-Pro mode, specifically to make use of short-term rainfall forecasts, will enable the model to generate more refined irrigation-scheduling advice to irrigators.

2 **Funding of a technical user-support unit,** which would continue to support the countrywide application of modelling tools in agricultural water management, should be considered. Currently, only the project participants are able to manage their water resources with the assistance of advanced modelling tools.

3 **GIS-based software should be developed** to help WUAs and IBs to use GIS to greater effect in the planning and implementation of canal maintenance activities.

Further reading:
To obtain the report, *Technology Transfer and Integrated Implementation of Water Management Models in Commercial Farming* **(Report No: TT 267/08),** contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za