

Introduction

This project relates to the transfer of technology and integrated implementation of the following models:

Agricultural Catchments Research Unit - ACRU

ACRU is an integrated agrohydrological modelling system capable of being used for, amongst others, water resource assessments, design flood estimations, crop yield assessments and irrigation water demand and supply evaluations. However, ACRU is not yet capable of easily representing complex catchment operating rules and thus for the purposes of this project it has been used primarily as a catchment-scale daily time-step hydrological rainfall-runoff model. ACRU was used to determine the streamflow from non-irrigated (i.e. dryland) lands in a catchment. The streamflow was used as input into the MIKE BASIN model (developed by the Danish Hydraulic Institute). The MIKE BASIN model was used to simulate the supply and demand interactions in catchments for given operating rules. The irrigated lands are dealt with by MIKE BASIN, and not ACRU, as the irrigated lands are subject to operating rules (which dryland land-uses are not) which are easily represented in MIKE BASIN. The ACRU model was developed by Prof R E Schulze at the School of Bioresources Engineering and Environmental Hydrology from the University of KwaZulu-Natal – Pietermaritzburg.

Water Administration System - WAS

WAS is a modelling system that promotes efficient operational management of water. WAS consists of four main modules that are integrated into a single program that can be used on a single PC or over a network. These modules can be implemented partially or as a whole, depending on the requirements of the specific irrigation scheme or water office. The four modules are summarized as follows:

- The **Administration** module administers the details of all water users of a scheme or water office. Information including addresses (owners, tenants and postal), scheduled areas, water quota allocations, household and livestock pipes installed, list of rateable areas (LRA), crops planted, planted areas and crop yields are managed in this module. All information can be printed.
- The **Water orders** module administers water usage through pressure-regulated sluice gates, water meters and measuring structures. Water orders can be captured using a water order form based on a flow rate and time or using meter readings based on a start and end reading. Conversion factors can be captured in WAS to convert meter readings automatically if necessary. A range of reports is available for printing that includes water allocations and water balances per user, water balance sheets per user and a water usage summary.
- The **Water accounts** links with the water orders module and administers all water accounts for a scheme or water management office. The user can choose between two major accounting systems. The first is the current Department of Water Affairs accounting system

and the second a full debit system, from which monthly reports can be printed, including accounts on pre-printed stationery, reconciliation reports, age analysis and audit trail reports.

- The **Water release** module 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. A schematic layout of the total canal network or river system is captured with detail such as the cross-sectional properties, positioning of sluices or pumps, canal or river slope, structures and canal or river capacities. Discharges are converted to the corresponding measuring plate readings where needed. Water distribution sheets and water loss analysis reports can be printed for canal or river systems.

Dr Nico Benadé initially developed WAS to capture water orders which were needed for an open channel simulation model. The model was further developed through Water Research Commission projects done at the Rand Afrikaans University and subsequently further developed by NB Systems. Dr Nico Benadé was responsible for the technology transfer of WAS.

**Crop Water Use Model
-SAPWAT**

SAPWAT is a crop water use planning model that can be applied at field or scheme scales. SAPWAT was developed by Mr C Crosby at Murray Biesenbach and Badenhorst and subsequently further developed by Mr P S van Heerden of PICWAT consultants. The SAPWAT model is used for planning purposes, and is 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.

**Soil Water Balance
model
- SWB**

SWB is a generic, mechanistic model for real time irrigation scheduling at field scale (i.e. for operational purposes). SWB has been developed by Prof John Allandale of the University of Pretoria. The model has been further developed in the course of this research project, and is now also able to be used for planning purposes. The model has been renamed to SWB-Pro to differentiate it from the previous version.

**Risk Manager
- RISKMAN**

RISKMAN is a simulation model of net cash-flow for water use and crop combinations at specified risk levels at a farming scale. The model was originally developed by Prof A Meiring at the University of the Free State. The model is generally applied at farm scale.

All the models share a common thread in that they can all be used to promote the improved management of water resources. Each of the models listed above has been developed over a number of years with funding from the Water Research Commission. For all the models independent technology transfer projects have been undertaken. This project relates to the integrated implementation of the models, targeting five Water User Associations and two Irrigation Boards across South Africa. The rationale for the integrated transfer of technology for the suite of models relates to the following fact: many of the models were developed prior to the promulgation of the 1998 National Water Act. The models were developed for very specific purposes. The 1998 National Water Act calls

for water to be used in an equitable, efficient and sustainable manner. Water users in South Africa require decision support to meet the objectives of the Act. As the models listed above cater for specific aspects of water resource management, and at specific spatial scales, it makes sense to technology transfer the suite of models to water users, so that a holistic optimal solution to challenging management situations can be found.

All models are driven by some form of input data, which is then transformed into information via computational processes housed through the models. A central approach of this integrated technology transfer (TT) project was to capture high quality data of the targeted participant Water User Associations and Irrigation boards in a Geographical Information System (GIS). It was clear from earlier WRC projects that stakeholders showed a strong interest in GIS packages, largely due to the understanding that the use of GIS promotes for spatial and temporal information. This is due to the graphical (visual) nature of GIS which enables features to be viewed in a spatial context. In order to promote the buy-in from potential WUA and IB participants, a key feature of the project was the collection of data pertinent to the WUAs and IBs which would then be captured in a GIS. The data incorporated in the GIS could then be used (with other input data) to drive the models associated with the TT project. The original thinking was to develop a unified database, from which all the models would draw their input-data, and write their output data. This thinking was revised in the course of the project, as a development of this nature would be very complex in terms of the additional computer programming involved, and would not necessarily add much value to the project. Instead, the data housed in the GIS can be exported for use by the respective models.

This integrated transfer of technology project targeted the commercial irrigation sector in particular since, according to the National Water Resources Strategy (NWRS, first edition, 2004), this sector is responsible for over 62% of South Africa's total water use. The terms of reference required the research team to (i) identify, (ii) negotiate with and (iii) select 5 – 7 Water User Associations or Irrigation Boards to participate in the technology transfer project. A key objective of the project was for the models to be used sustainably after the completion of the project to increase the efficiency of water use. As such, the potential participant WUAs / IBs were evaluated in terms of (i) their user needs for the respective models, (ii) the level of commitment shown and (iii) the level of infrastructure of the respective schemes. The participants were ranked in terms of these criteria, and short-listed. It is hoped that the WUAs / IBs which were selected will act as centres of excellence, from which other WUAs / IBs can learn over time.

At the first reference group meeting of the project, it was pointed out that the term “technology transfer” is possibly not the most appropriate option available, with the term “technology exchange” being a preferable option. The reason for this stems from the fact that both the research team and the representatives from the participating Water User Associations, Irrigation Boards and associated farming circles would benefit from a mutual exchange of knowledge. The research team did in fact learn a tremendous amount from the participating WUAs and IBs, as well as from farmers, which in some cases resulted in the models associated with the technology transfer project being modified to better suite the needs of the WUAs and IBs. It is thus requested that throughout this document, the term “technology exchange” is inferred where the words “technology transfer” are used.

Project objectives and the progress made against the objectives

The project had 13 clearly defined objectives. These are detailed below. Comments related to the objectives are included in italics.

1. The research team was to undertake an exploratory overview of potential target irrigation scheme options, and to provisionally select 5 to 7 irrigation schemes as study areas in consultation with WRC and DWAF.

The irrigation scheme options include Water User Associations, or Irrigation Boards which have not yet converted to WUAs.

2. The research team was to forge an improved understanding of the minimum data requirements common to all the models associated with the Technology Transfer project, as well as the intricacies of configuring and operating the respective models.

It became clear that a central database, capable of driving all the models associated with the TT project was not viable in the course of the project. The models all have very unique data requirements, and operate at different scales. A unified database suitable of housing data inputs for all the models, as well as the outputs generated from the models would be very complex, and would not yield any significant value to the project. The research team did however realise the importance of the data captured in the GIS. In effect the GIS data (captured in the GIS database), could be exported (manually) to the databases of the respective models.

3. The research team was to consult with end-users (staff of Water User Associations (WUA) and farmer representatives) of the 5 to 7 provisionally selected irrigation schemes to:

- Explain the purpose of the Technology Transfer project,
- Present different models for water management decision support,
- Identify water management requirements on irrigation schemes,
- Identify potential users and capture associated user need requirements, and
- Determine which data are available for the identified schemes.

The research team made contact with numerous candidate participant Irrigation Boards and WUAs. Consideration was given to the user needs of the candidates (i.e. the potential need for the models being technology transferred), as well as the interest shown by the candidates to participate in the study, as well as the resources available (e.g. staff, computers, etc.) to the candidates. One of the key objectives of the project was for the models to be used sustainably after the completion of the project. Therefore only those WUAs and IBs which displayed a high user need for some or all of the models, while exhibiting a high degree of interest combined with an acceptable level of resource availability, were short-listed as potential candidates for the project.

4. With a better understanding of each irrigation scheme, the research team was to revisit the schemes with the appropriate team members. The objective of the "revisit" was to:

- Highlight to the participant stakeholders the integrated modelling approach within the context of the water supply system and to demonstrate the integrated application of these models in water management, and
- For stakeholder participants to share local knowledge with the research team.

5. With the information gleaned from objective 4, the research team was to reassess the user need requirements.

6. Following on from objective 5, the research team was to decide which schemes were to be addressed within available funding constraints and the combination of models that needed to be used for each selected scheme.

The following WUAs and IBs were selected to participate in the study:

- The Loskop Irrigation Board
- The Nkwaleni WUA and Mfuli and Heatonville Irrigation Boards in the Mhlathuze Catchment
- The Vaalharts Water WUA
- The Oranje-Riet WUA
- The Lower Sundays River WUA
- The Gamtoos Irrigation Board, and
- The Lower Olifants River WUA.

A map of South Africa is shown below in Figure 1 which illustrates the geographical location of the respective participant WUAs/IBs. The seven participating WUAs/IBs are spread throughout South Africa and thus have different climatic conditions.

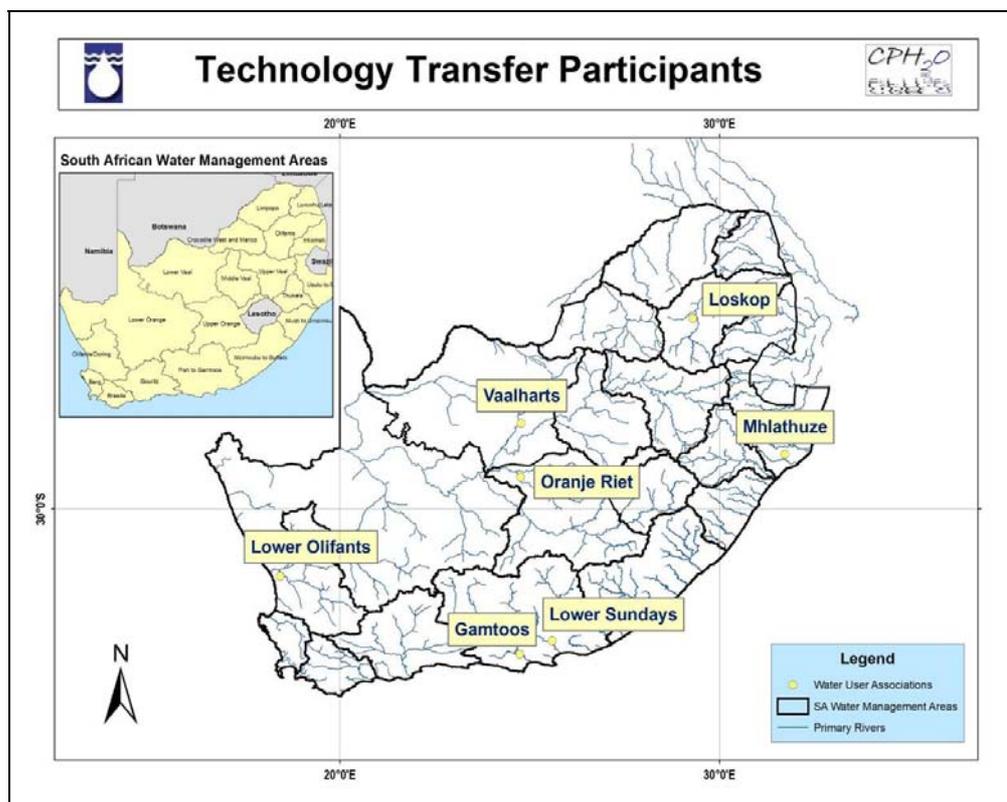


Figure 1 A map illustrating the location of the participant WUAs / IBs

Table 1 below details the needs of the participant WUAs / IBs for the models (or model modules) forming part of the TT project.

Table 1 User Needs of the Water User Associations and Irrigation Boards

IB / WUA	ACRU	MIKE BASIN	SWB	RISKMAN	SAPWAT	WAS			
						Admin module	Accounts Module	Request Module	Release Module
Mhlathuze	High Interest								
Loskop	High Interest		High Interest	High Interest		Already Using	Already Using	Already Using	High Interest
Vaalharts				High Interest	High Interest	Already Using	Already Using	Already Using	High Interest
Oranje Riet				High Interest	High Interest	Already Using	Already Using	Already Using	High Interest
Lower Olifants						Already Using	Already Using	Already Using	High Interest
Lower Sundays River			High Interest			High Interest	High Interest	High Interest	High Interest
Gamtoos			High Interest	High Interest		Already Using		Already Using	

 HIGH INTEREST SHOWN IN MODEL / SYSTEM
 ALREADY USING THE MODEL / SYSTEM

7. Within the research team, test, evaluate and adapt the integrated GIS and modelling system for the successful implementation of the models to the targeted research areas.
8. Collect spatial information and install an appropriate GIS.

Very detailed GIS information was captured in the course of the project. As the costs of capturing detailed imagery of the WUAs / IBs and subsequent annotation in GIS is high, WUAs / IBs interested in the GIS component were asked to co-fund this component. The table below details the WUAs for which GIS information was captured. Co-funding equal to half the cost was received from the relevant WUA / IB for which the GIS tasks (i.e. imagery acquisition and/or GIS annotation) was undertaken.

Table 2 below illustrates the WUAs / IBs which opted for GIS tasks to be undertaken.

Table 2 GIS Needs of the Project Participants

IB/WMA	Imagery	Annotation
Mhlathuze	Available	Available
Gamtoos	Available	Required
Loskop	Required	Required
Lower Olifants	Not interested	Not interested
Lower Sundays River	Required	Required
Oranje Riet	Available	Available
Vaalharts Water	Required	Required

	Available
	Required
	Not interested

9. Populate database (collect/collate/verify data)

A single unifying database was not created. The data captured in the GIS database was exported (manually) to the databases of the respective models.

10. Install the appropriate combination of models for the selected target groups e.g. WUA staff, farmer study groups and advisors/extension officers

The models or modules with a high user need were configured and technology transferred to the relevant participant WUAs / IBs.

11. Develop and present training courses for end-users (WUA staff, extension officers/advisors/farm leaders, etc.)

User manuals were prepared for the various models. In addition to this training courses were held for the respective models and GIS.

12. Interact with end-users through workshops or information sessions to evaluate acceptance and effectiveness of the technology transfer.

In general, the research team visited the respective WUAs / IBs to give effect to the transfer of technology associated with the models the WUA / IB showed a high interest in. In addition to this, a 3-day workshop was held, to which all WUA / IBs and individual farmers were invited. An open GIS training course was also offered to interested participants.

13. Put in place a process for hand over and continuation, i.e. formulate an exit strategy.

A significant amount of work was done to either further develop the respective models, or the relationship between the researchers amongst themselves and/or between the researchers and the participating WUA / IBs to ensure that the models would be used sustainably over time. The current demand for some of the TT models is very clear, and the models (or modules) are either currently being used, or will soon be used. However, for other models, the demand is still growing. For example, the use of SWB for real-time irrigation scheduling is anticipated to become utilised to a far greater degree in the future, particularly after the Compulsory Licensing process has been undertaken in over-allocated catchments. The focus has been to develop the models to be used by consultants, who can then service the growing needs for this type of service in the future. It must be borne in mind that the models have generally been developed by academic organisations, and hence the focus of the models has often been on scientific correctness, and not necessarily on packaging the software to be used by consultants in a cost-effective manner. The objective for the models to be used sustainably over time had a large bearing on the actions and developments initiated in the course of the project. Further details in this regard are provided in the sections below. User manuals have been developed for the models, which are downloadable of the World Wide Web.

Project results

The project goals have been achieved in adapting, combining and implementing the models to the selected WUAs/IBs for which a high user need was shown. The project has resulted in the research team members being more aware of the integrated user needs of irrigation schemes. This has resulted in some of the models being further developed during the course of the project to with better integrate with one another. The sections below detail the progress made with respect to the various models and GIS component of the project.

- The GIS component of the project

The participant WUAs / IBs were given the option of having detailed data relevant to the schemes captured in a GIS. This option was more favourably received than originally anticipated. Not only did the vast majority of the participating WUAs / IBs opt for the GIS to be undertaken for their management areas, they also agreed to co-fund the GIS component (paying for half the costs associated with the GIS tasks). Participants also, in general, opted for more detailed GIS tasks to be

undertaken than the research team anticipated they would. The GIS tasks included (i) the capture of imagery at a fine scale of resolution, and (ii) the use of the imagery to annotate features such as fields, canals, roads, weirs, etc. The option was given to the WUAs / IBs to have the imagery flown at different options of resolution, (i.e. 0.5 m, 0.75 m and 1 m pixel resolution). The cost of flying at a higher level of resolution becomes higher in a non-linear manner. It was anticipated that most WUAs / IBs would opt for the 1m pixel resolution option, as this would be the cheapest option. A few of the WUAs / IBs, bearing in mind that they were responsible for half the bill, opted for the 0.75 m pixel resolution option even though it was more expensive.

There were some delays in the acquisition of the GIS imagery, largely due to poor weather conditions. The detailed imagery has enabled very detailed annotation of features such as farm fields, canals, waste-canals, weirs, dams, etc. This information is valuable not only to the participating WUA / IBs, but will also be valuable to other research projects. The WUAs / IBs make use of the GIS imagery and annotation in various ways. However, it appears that the GIS has on its own provided the WUAs / IBs with better information to help plan and operate their areas of management. For example, the GIS enables the WUAs / IBs to independently verify crop types and areas with certainty without having to request this information from the water users. The GIS imagery provides an effective medium to identify where canals are in a poor state of disrepair, or where waste-canals are required. The GIS component of the project has significantly contributed to the success of the project.

- *ACRU-MIKE BASIN*

In the course of the project developments were undertaken to link ACRU with MIKE BASIN via a GIS interface. Although MIKE BASIN has not been developed with funding from the WRC, the WRC has funded some projects where MIKE BASIN has been used. ACRU is a rainfall-runoff model, whereas MIKE BASIN is a node-and-channel network model. The relevance is that a node-and-channel network model makes use of streamflow (which is output from ACRU) as one of its inputs. Given the fact that a number of the catchments in the country are considered to be over-allocated, linking ACRU with MIKE BASIN has enabled a methodology to quantify the extent of over-allocation. Water resource planners in South Africa currently make use of the Water Resources Yield Model (WRYM), a node-and-channel-network model, which is fed with streamflow generated from the Pitman model. The ACRU-MIKE BASIN linkage provides an alternative to the Pitman-WRYM combination, and has some advantages over the Pitman-WRYM, which relate to (i) the time-step that the models operate on (i.e. daily as opposed to monthly), and due to the fact that ACRU is a process based hydrological model, which allows various landuse and management practice scenarios to be considered which are not suited to the Pitman modelling framework since it is a regression model.

As part of the TT project, developments were undertaken that enable ACRU be easily set-up from within a GIS environment, using GIS data available at a national scale. The ACRU-MIKE BASIN models were then configured for the Loskop Catchment area, as well the Mhlathuze Catchment, as both of these catchments are deemed to be over-allocated according to the National Water Resources Strategy. It is not plausible that the members of the WUAs and IBs will themselves directly use the ACRU-MIKE BASIN software, as the models need to be operated by experienced hydrologists or water engineers. What is plausible though is that the WUAs and IBs make use of consultants who have access to ACRU-MIKE BASIN, particularly in over-allocated catchments.

- *WAS*

The Water Administration System (WAS) consists of four main modules, which include the administration module, the accounts module, the water order module, and the water release module. The software can be utilised by a CMA or by a WUA. Many of the participating WUAs / IBs were

already using some of the WAS modules. In general, the one module that was not being used was the release module. The reason for this is that of all the modules, the release module is the most expensive to configure and most difficult to operate. Another reason is that many of the water control officers make use of their own rules (some computer aided) to aid them with water release decisions.

In the course of the TT project the release module has been configured for most of the WUAs / IBs, and the water control officers have been trained in the use of the release module software. The feedback from the water control officers has been very favourable, and it is probable that the release module will continue to be used sustainably by the water control officers participating in the research. In addition to this, the Department of Water Affairs and Forestry has shown an interest in the WAS model and may request that all WUAs use the WAS software to generate their water disposal reports.

A GIS based script has been developed which enables the WAS database to be queried from within the GIS environment. It is unclear at this stage if this development will be of great value to the WUAs / IBs. If it is, the recommendation will be put forward to more formally integrate WAS with a GIS environment.

- *SAPWAT*

SAPWAT is a crop water use model which is generally used for planning purposes at various spatial scales (e.g. WUA scale to field scale). The model has been very successful over time, and the research team explored the reasons behind this. Some of the key reasons for SAPWAT's success include the following:

- ❑ The model was pre-packaged with key input data (weather, soils & crop data), which were used to drive the model. The implication is that potential users did not have to spend time and effort to find, format and capture this data,
- ❑ The model was structured in a manner that is relatively easy to understand. It is quite easy to configure a scenario in SAPWAT, to run the model and then to output and display the results. The turn-around time to simulate the water use of a crop for a given scenario is thus very quick, and the results are accurate within acceptable levels of confidence. The result is that many consultants and DWAF personnel make use of the model.
- ❑ The model is scientifically based, and finds a sound balance between keeping the model practically operable and scientifically sound.
- ❑ The model is well supported by its developers, who are able to respond to queries and/or requests very quickly.

As the SAPWAT model was already being used by many of the participant WUAs / IBs, there was not much scope to further technology transfer SAPWAT. SAPWAT was however used to simulate the crop water use requirements for the dominant crops and management practices for each of the participant WUAs. This allows a quick comparison to be made of the impact of spatial location and management practice of given crops for different areas in South Africa.

- *SWB*

The SWB is a field-scale crop growth model, which is able to accommodate different crops, as well as different irrigation system and management options. In response to feedback received from the participant WUAs / IBs, a number of developments were undertaken on the SWB-model. Some of the key developments include:

- ❑ The SWB-model was pre-packed with weather and soil data for South Africa. This enables it to be used for planning purposes, as use is made of long time series of historical weather data.

- ❑ The Graphic User Interface to SWB was modified, to make it more user-friendly.
- ❑ An initial conditions scenario is generated by utilising the pre-populated database, which the user can then adjust. The implication is that the turn-around time to get a base run initiated is significantly improved.
- ❑ A scenario generator option has been developed, which allows multiple crop and irrigation scenarios to be configured with ease.
- ❑ The model has been developed to provide model outputs which can be readily fed into the RISKMAN model, thereby allowing hydro-economic scenarios to be considered.
- ❑ A number of software upgrades were undertaken. For example the database was migrated from a paradox database to that of Firebird SQL database.

The developments listed above were deemed to be very important to enable the sustained use of the model after the completion of the project. In addition, much effort was expended to promote the use of the model by end users. The SWB model has been renamed to the SWB-Pro version, in order to distinguish it now from the previous version. The TT project team believes that the demand for the SWB-Pro software will continually increase over time, as the cost of water increases and the opportunity cost of water is recognised by the water users.

- *RISKMAN*

RISKMAN is a software package that enables water users to assess the risks of certain water use and land use (i.e. crop) options. SWB-Pro has been developed to generate outputs which are then used as inputs into the RISKMAN model. The SWB-Pro & RISKMAN models combined offer WUAs and water resource managers in general a tool to help assess the hydro-economic implications of various water management decisions.

The demand shown for RISKMAN in the course of the TT project was not very high, but as with the SWB-Pro model, it is anticipated that this demand will soon grow, particularly following the completion of the Compulsory Licensing process in over-allocated catchments. The SWB-Pro / RISKMAN combination may even be used to help guide licensing decisions during the Compulsory Licensing process, as the combined set of models enables the hydro-economic impact of various landuse and management scenarios to be simulated.

It can be said that the objectives of the contract have been achieved for two main reasons. Firstly, the models have been successfully technology transferred to the WUAs / IBs which illustrates a high interest for the respective models. Secondly, the models have been further updated in response to valuable feedback received from the participant WUAs and IBs, which will promote the sustained use of the models after the completion of the project.

Capacity building

The capacity of the research team has been built in response to the integrated nature of the technology transfer. The interaction with persons from the participant WUAs and IBs has further developed the understanding held by the research team members regarding the practicalities faced by the WUAs / IBs. This is very important, as the research team members are in effect developers of solutions, which are translated into algorithms in software, for application by the WUAs / IBs, either directly or indirectly. An appreciation of the realities faced by the WUAs / IBs enabled the research team to either develop more appropriate solutions, or to package the solutions in a manner that is useful to the end-users.

The capacity of the participant WUAs and IBs has been increased, in that they have been exposed to the models associated with the TT project. They have also been exposed to GIS, and have had training in the use of GIS.

In the course of the project the research team presented the various models to persons in the Department of Water Affairs and Forestry (Pretoria office). In general, the models used for the TT project are of a higher spatial and/or temporal resolution than the models currently used in DWAF. Although DWAF has not formally requested the models (other than WAS), they are, as a result of the project, more familiar the details and functionality of the models forming part of the TT project.

Conclusions

The technology transfer project has in effect been a technology exchange project, the goals of which have been achieved. The WUAs / IBs have shown a very high interest in the use of GIS, which is very encouraging, as the GIS data, if kept current over time, will provide valuable input data for the various models forming part of the TT project. The current user needs for some of the models is very high, resulting in the models either being used now, or the intention to use the model in the near future (e.g. WAS & SAPWAT). For some of the other models the user need is growing, and is anticipated to grow significantly once the compulsory licensing process has been completed in many of the over-allocated catchments in the country. Models like SWB and RISKMAN will be very useful to test the hydro-economic impact of various water-use and land-use scenarios. Like-wise, the ACRU-MIKE BASIN model combination is well placed to assist water resource managers and stakeholders evaluate water management scenarios.

Recommendations

1. To further develop the ACRU – MIKE BASIN model combination to also include RISKMAN. The reasons for this are:
 - ❑ The SWB-Pro is currently unable to simulate catchment operating rules (which will have an impact on the quantity of water available to water user, particularly when restrictions are imposed), and
 - ❑ The SWB-Pro is unable to simulate return-flows.

As many of our catchments are over-allocated, water resource managers will want to assess the hydro-economic impacts of various operating rules, and license allocation decisions on water users. The ACRU-MIKE BASIN linkage is a useful platform to work from. What is missing is the economic component, which is the RISKMAN model. The alternative will be to further develop the SWB-Pro model, but this may be significantly more complex than the option being tabled.

2. The SWB-Pro model should ideally be further developed to also make use of short term rainfall forecasts, which may influence the scheduling advice generated from the model. The SWB-Pro currently does not give any consideration to short-term rainfall forecasts.
3. It is recommended that the WRC and/or DWAF provide funding to support a technical user support unit, which continues supporting the use of the models associated in the Technology Transfer project. Although the Technology Transfer project was successful, it targeted only 7 WUAs / IBs, which is a very small percentage of the total number of WUAs and IBs in the country. At some stage all water users will require assistance in the management of their water, be it a catchment scale, scheme scale, or field scale. An organisation such as the former Computing Centre for Water Research (CCWR) would be a suitable organisation to provide support and assistance for this purpose.

4. GIS based software should be developed to help WUAs / IBs with the planning and administration of canal maintenance. The GIS is very visual facilitating an improved understanding of the issues to users.