Determining How Much is Just Enough

Water laws are becoming increasingly stricter, with especially large water users, such as farmers, having to find new ways of accounting for every drop they use.

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Sprinkler irrigation.

South Africa is a water-scarce country, which means it water resources are limited. The country does not have that frequent rainfalls to ensure adequate crop growth. The region for agriculture also plays a role. Once planted, it all depends on the rain to fall and water the crops. The only other option left is to use the water resources in terms of reservoir dams, rivers and other methods to irrigate the land manually. This immediately opens up the field to invent new and develop existing methods of crop irrigation.

WHERE DOES THE WATER COME FROM?

All major water resources are captured in reservoir dams. From these dams water can be let into large concrete-lined canals to irrigation districts. The main canals will run along the length of the irrigation district. Smaller feeder canals can then tap of from the main canals and take water deeper into the district and various farms. Community canals will again take to the specific farms and plots where water is diverted through sluices to the storage dams. Once stored, the required irrigation method can be applied.

HOW MUCH WATER IS NEEDED?

Various studies are devoted to determine the volume of water required by any irrigator in respect to the crops to be irrigated, land type, climatical condition, and so forth. From a hydrological engineering point of view, only the required amount of water is necessary. From this, a cumulative volume of water can be released from the source to be distributed into the canal network. The volume to water needs to be adequate as all the requirements of the users must be met. The question may be raised that the water can be let into the canals at a constant basis and users take water as needed, but then one realises again that it is South Africa and we do not have that amount of water to our availability. For this reason also government has enforced legislation to conserve the little amount of water we have.

In our attempt to distribute the water as intended we therefore should release only the required amount of water while allowing for water losses along the canal network. Two methods of determining this volume of water exists.

In the first method, the manual method, users will apply for water by the

means of water application forms. All the forms will then be processed and a single daily volume of water can be determined. This volume, which will take all losses into account, can then be released on a weekly basis. In the second method a database of the entire canal network as well as all the users can be built up into a computer program. Allowing still for losses, the computer program can calculate the same release volume of water. The second method can be seen as the automated computerised method.

The computer originated release volume can only be correct if the database it draws its information from is correct and up to date. From there all the benefits of computer technology can be applied and utilised to successfully manage and distribute the available water.

RESEARCH OBJECTIVES AND AIMS

Extensive cycles of data verification therefore should take place to authenticate the existing database. This in fact was the purpose of the intended research study. The computer program as applied to the Vaalharts Irrigation Scheme (VHIS) is the Water Administrations System (WAS). WAS is designed to be a management tool for irrigation schemes and water management offices that want to manage their water accounts and water supply to users through canal networks, pipelines and rivers. WAS is developed and maintained by N Benadé and was funded by the Water Research Commission (WRC) and the Department of Water Affairs and Forestry (DWAF).

The WAS program has four modules, namely: the administration module, water request module, water accounts module and the water release module. All of these are already implemented except for the release module, which is implemented only partially. To have it fully implemented all the data should be verified, updated and it should be ensured that the program can calculate the correct volume of water to be released. Initial tests showed that WAS under-calculates values in the range of 40 – 45%. The aim of this study would be to fully implement the release module by verifying all data and calculation procedure through achieving the following objectives:

- Conducting meetings and consultations with the members of the irrigations scheme and local community. Especially the water control officers can relay valuable information like sluice numbers, canal geometry and canal capacity.
- From engineering design drawings more technical data can be obtained in terms of slope, geometry and section lengths.
- In the early nineties (1991 – 1993), both the main canals were enlarged by converting the shape to a combined trapezoidal canal. The main purpose would be for improved canal utilisation. The combined section can yield a bigger discharge than the original normal canal or a totally new canal, and in times of low flow evaporation is reduced due to the smaller area exposed to the sun. Currently the program understands that a normal trapezoidal canal section is in use, while in reality a combined canal section is used. The normal water release is still calculated regarding this situation but, mathematical calculations can be done to investigate the difference in discharge between these two sections. Current calculations could have the effect that either too much or too little water is calculated for the canal. Applying some mathematical calculations proved that too much water is constantly calculated and the WAS calculation procedure can now be corrected.
- The most painstaking method of all is to manually collect all other data in the field. Here data like canal geometry, section lengths, sluice verification, etc. was done. This proved to be valuable for further verification methods.

Once all data was collected verified and updated, a cycle of calculation comparisons could be carried out. If the calculation process can be proven correct on a single feeder canal, then the same principle can be applied to the rest of the canal network. In an initial calibration test conducted the release volumes of only requested water (no water losses were added) was compared. In Table 1 the values indicated in orange shows that no differences were encountered. With the basic calculation process assured, the calibration of data, needed to calculate the full release volume (including water losses), could be carried out.

The only actual aspect that differentiate between the calculation procedure of WAS and the VHIS is the way that losses are calculated and the fact that WAS offers more features for irrigation scheme management. The final step therefore is to calibrate the WAS database in order that the losses will be calculated correctly.

Typical flood irrigation.

TABLE 1
CALCULATION COMPARISON RESULTS

	Period 14		Period 30		Period 46	
	Description	Volume	Description	Volume	Description	Volume
VHIS	Without losses	138600	Without losses	241200	Without losses	279000
	With losses (excel)	223692	With losses (excel)	359412	With losses (excel)	418803
WAS	Without losses	138600	Without losses	241200	Without losses	279000
	With losses (WAS)	232968	With losses (WAS)	355899	With losses (WAS)	397506
	% diff- without losses	0.0	% diff- without losses	0.0	% diff- without losses	0.0
	% diff- with losses	4.1	% diff- with losses	-1.0	% diff- with losses	-5.1

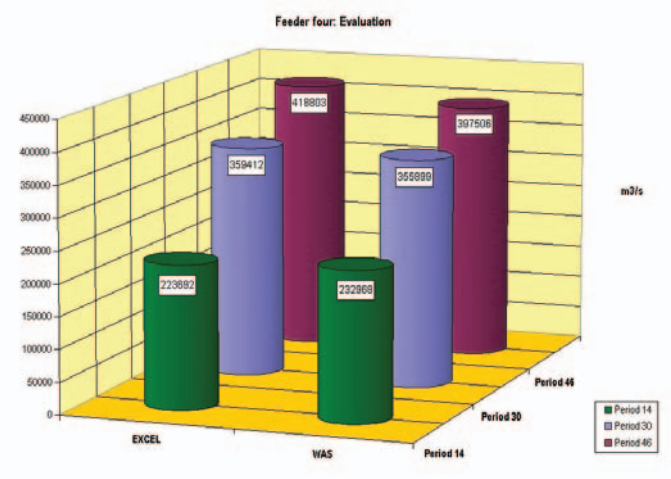

Figure 1

After this database was calibrated and some final adjustments were made to canal geometry, the full release volume were calculated and compared. As indicated in Table 1, the values in green, show that very small differences were encountered. Figure 1 shows the differences of the two calculation procedures after the final calibration.

RECOMMENDATIONS

Valid input data delivers valid output data. In order to conclude the study successfully, one needs to realise that for a study like this the more accurate the database is, the more accurate and valid the results will be. The calculation comparison can only be correct if the data has been verified by means of given method. Through proving this database valid it can be said that the release module can be implemented as required by the irrigation scheme.

It is recommended that all the satisfactory results delivered by the comparison process, should now also be implemented on all the other feeder canals. Completing this exercise will update all data accordingly and render it viable to be used in the calculation of actual release volumes for the canal network. Once the release module is fully implemented, all module of the WAS program can be used on the VHIS.

WAS is already implemented on a number of other irrigation schemes in South Africa with very satisfactory results. Some schemes use WAS only for the accounts, while others use it for the administrational benefits. The intention is to fully implement WAS at the VHIS, making it the water management tool of the scheme. The VHIS also lends itself to future developments of WAS and water management. This will also be in line with new proposed community projects where agriculture in South Africa needs to be improved. Adequate water supply is a much needed commodity for any upcoming farmer. Ongoing calibration of the canal data and calculation procedure as well as an open line of communication with the community should therefore take place until the users and developer are satisfied.

Water losses due to defects in the canal should be minimised. WAS accommodates seepage, but the increase of defects could again result in inaccurate calculations. It could also be recommended for implementing or incorporating a global positioning system phase using geographic information systems which could help considerably locating sections on the canal, read and use canal network data and pin-point certain sections on the canal. A water scheduling program could help to assist farmers and ensure the sustainability of the water resource and better planning and management of their water quota respectively.