CATCHMENT MANAGEMENT- MODEL EVALUATION: VERIFYING DATA FOR THE IMPLEMENTATION OF THE WATER RELEASE MODULE OF THE WAS PROGRAM

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Abstract

The Water Administration System (WAS) is designed to be a management tool for irrigation schemes and water offices that want to manage their water accounts and supply to clients through canal networks, pipelines and rivers. The ultimate aim of WAS is to optimize irrigation water management and minimize management-related distribution losses in irrigation canals. This research project focus on the implementation of the water release module of the WAS program at the Vaalharts irrigation scheme. WAS consists of four modules that are integrated into a single program that can be used on a single PC, a PC network system (in use currently at Vaalharts) or a multi-user environment. These modules can be implemented partially or as a whole, depending on the requirements of the specific scheme or office. The four modules are an administration module, a water request module; water accounts module and a water release module. The first three modules are already implemented at Vaalharts, while module four is implemented only partially. This module links with the water request module and calculates water releases for the main canal and all its branches allowing for lag times and any water losses and accruals. Any researcher in this field should first understand where water comes from and how it will be utilized before any calculations are attempted. Only then manipulation of the release volume can commence. To precisely calculate this water release, accurate data is needed to ensure that the correct volume of water is released into the canal network. This can be done by verifying existing data with field data. To optimize the management of the irrigation scheme the fully implemented WAS program need to be installed and running at the scheme. A series of data and calculation verification needs to be executed. The exercise will show the adequacy and correctness of the available database WAS uses to do the release calculation from. This will ensure improved management of the irrigation scheme, catchment and water resource sustainability. It is planned that the information generated from this project will be used in the compilation of an integrated catchment management information system, currently underway in the school of Civil Engineering and Built Environment at the Central University of Technology, Free State, South Africa.

Keywords: water administration; irrigation; water distribution; canal network; water utilization; agricultural; reach distances; lag time; discharge; water.

1. WHY DO FARMERS IRRIGATE THEIR LAND?

As a child all of us wondered where bread, maize and other products come from. As the years passed on we learned that all of the everyday necessities come from agriculture. The soil is prepared, seeds are planted and watered and then one only needs to wait for it to grow so that it could be harvested. Once harvested, all of our favorite consumables can be produced, packaged and sold. If only this was as easy as it sound. One of the major factors affecting this process is water. Rainfall and sufficient soil moisture content is the only thing that will make any crops grow.

Various other publications have mentioned the fact that South Africa is a water scares country. This is due to the fact that our annual rainfall varies from 105 mm to 1064 mm (Ayoda, 1988). We do not have that frequent rainfalls to ensure adequate crop growth. The region for agriculture also plays a role. Once planted, 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 (Benadé *et al*, 2002).

2. HOW DO FARMERS IRRIGATE THEIR LAND AND WHERE DOES THE WATER COME FROM?

The moment any water user has the water resources available, he can choose from various options to irrigate the crops. The water user therefore needs a storage dam on the farm where water can be collected for irrigation purposes. Once stored any irrigation method can be applied. In flood irrigation water is led under gravity to the crops and the entire plot is flooded with water. Centre pivot, sprinkler and drip irrigation requires a pump to create pressure to distribute the water to the plot. As with any other resources, water also requires management and rightful distribution amongst all the interested parties (DWAF, Manual on water control). Since crops can be irrigated by another means than rainfall, all major water resources captured in reservoir dams could be utilized for this purpose. 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.

3. WHY IS IT NECESSARY TO VERIFY THE DATA?

To optimize the management of the irrigation scheme the fully implemented WAS (Water Administration System) program need to be installed and running at the scheme. It is for this reason that a series of data verification and calculation comparisons needs to be executed. Since the WAS program is not yet fully implemented at the Vaalharts Irrigation Scheme (VHIS, Figure2), this exercise will take all the data used in calculation processes into account and validate it for correctness. The exercise will show the adequacy and correctness of the available database WAS uses to do the water release volume calculation from. Any results obtained after this procedure can be trusted and will reflect appropriate and correct volumes of water delivered to users. No user will receive less water that applied for and no water will be lost due to calculation errors or incorrect calculation data. This will ensure improved management of the irrigation scheme, catchment and water resource sustainability.

4. WHAT IS THE VOLUME OF WATER REQUIRED?

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, etc. (Crosby *et al*, 2000). 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 realizes again that it is South Africa and we do not have that amount of water to our availability. For this reason also government have enforced legislation to conserve the little amount of water we have (Water Act, 1999).

In out 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 build 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 computerized method.

The WAS program will use the existing database and determine a depth of water flow that will reflect a required release volume of water (m^3/s). The computer originated release volume can only be correct if the database it draws its information from is correct and up to date. Figure 3 shows the calculation procedure that WAS uses. From there on all the benefits of computer technology can be applied and utilized to successfully manage and distribute the available water.

5. RESEARCH OBJECTIVES AND AIMS

Extensive cycles of data verification therefore should take place in order to authenticate the existing database. This in fact was the original purpose of the intended research study. The computer program as applied to the VHIS is the WAS program. 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 Dr. N. Benade and were 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. In order 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 is under calculating values in the range of 40 – 45 %. These deviations should be adapted and corrected to more acceptable ranges. 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 utilization. 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. After the database calibration and some final adjustments were made to the canal geometry, the full release volume were calculated and compared. As indicated in table 1, the values in green, show that very small, yet acceptable differences were encountered. Figure 1 shows the differences of the two calculation procedures after the final calibration

6. RECOMMENDATIONS/CONCLUSIONS

Valid input data delivers valid output data. In order to conclude the study successfully, one need to realize 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 a 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 minimized. 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.

7. REFERENCES

AYOADA, J. O.
1988. Tropical Hydraulics and Water Resources, (1st ed) Macmillan Publishers. Pp 189 – 239

BENADÉ, N., ANNANDALE, J.G., JOVANOVIC, N.Z.
2002. The Development of an integrated information system for irrigation water management systems for irrigation water management using WAS, SWB and RISKMAN computer models. WRC Report No. 946/1/02 SOUTH AFRICA. Department of Water Affairs and Forestry. Manual for Water Control. Pretoria: Government printer.

CROSBY, C.T., DE LANGE, M., STIMIE, C.M., VAN DER STOEP, I.
2000. A Review of Planning and design Procedures Applicable to Small-Scale Farmer Irrigation Projects. WRC Report No. 578/2/00 pp. 3-1 – 3-14.

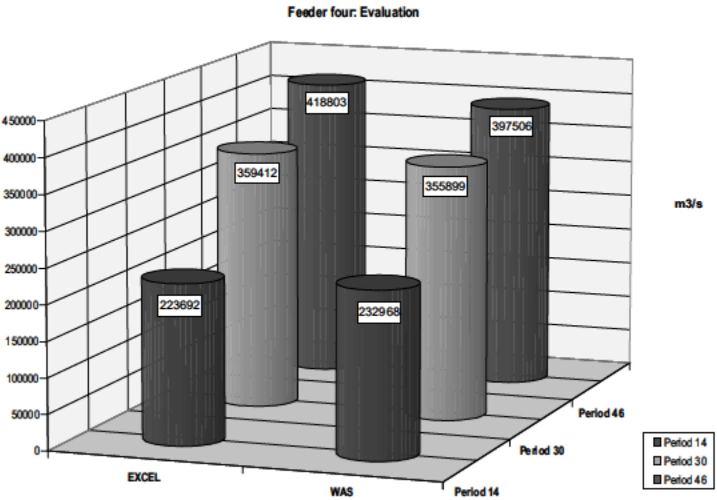
SOUTH AFRICA.
1999. Water act, act 45 of 1999. Pretoria: Government printer.

Table 1: Calculation comparison results.

	Period 14	
VHIS	Description	Volume
	Without losses	138600
	With losses (excel)	223692
WAS	Without losses	138600
	With losses (WAS)	232968
	% diff without losses	0.0
	% diff with losses	4.1

Period 30	
Description	Volume
Without losses	241200
With losses (excel)	359412
Without losses	241200
With losses (WAS)	355899
% diff without losses	0.0
% diff with losses	-1.0

Period 46	
Description	Volume
Without losses	279000
With losses (excel)	418803
Without losses	279000
With losses (WAS)	397506
% diff without losses	0.0
% diff with losses	-5.1



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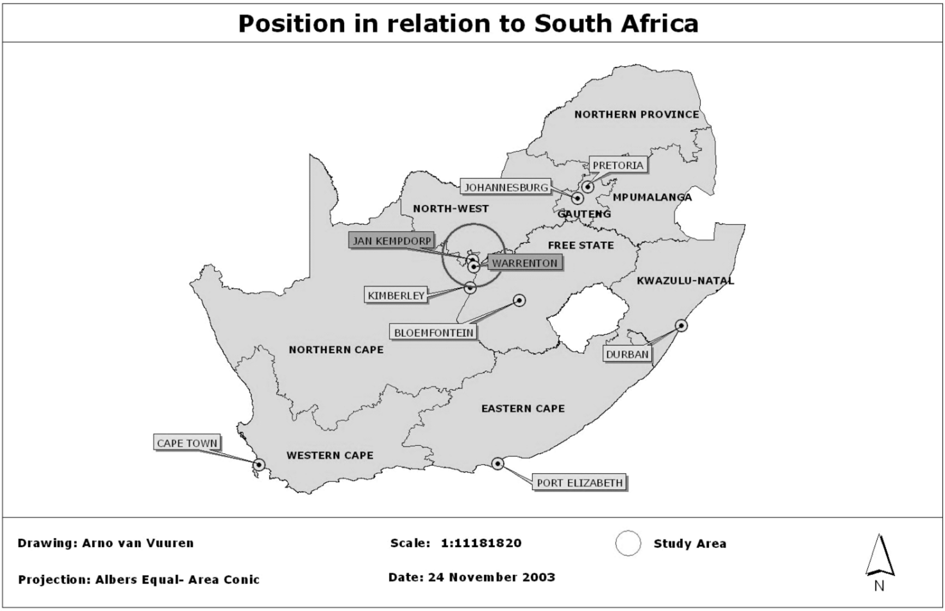

Figure 2: Vaalharts Irrigation Scheme.

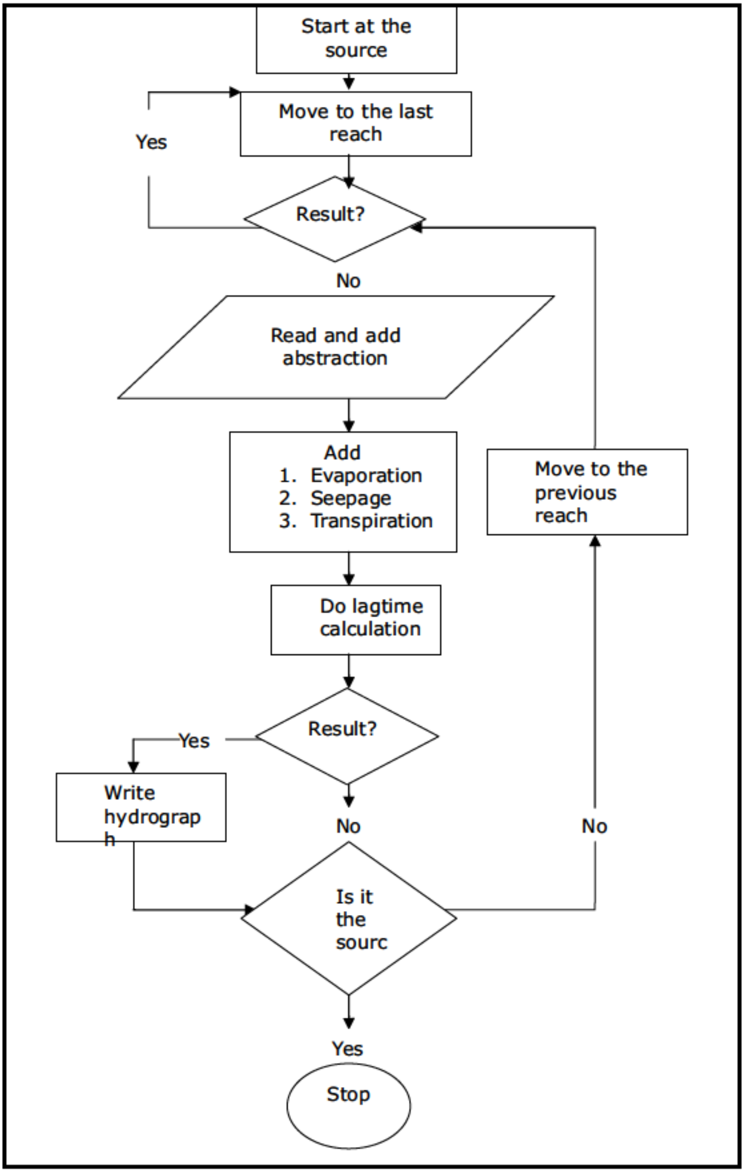

Figure 3: WAS calculation procedure.