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International Commission on Irrigation and Drainage (ICID)

WATSAVE AWARDS 2011

Technology Award

Summary of Messrs Pieter S van Heerden and Charles T Crosby's work

"SAPWAT 3: Irrigation Water Planning Tool"

(continued on next page)

SANCID WATSAVE NOMINATION

Improved irrigation water use planning and irrigation system design through SAPWAT3

The innovation

Irrigation water managers from farm level to scheme level, as well as designers of irrigation systems require an easy to use planning tool for water requirement estimates to enable them to supply the right amount of water at the right time to a crop. Good planning of irrigation water requirements for the irrigation industry will advance the overall management of water and its distribution between human, industrial, irrigation and environmental requirements. In South Africa, where a number of the major rivers are already over-extended, and where irrigation uses about 60% of the total water supply, good planning and management of irrigation water is of utter importance to increase the efficiency of irrigation water use.

A user-friendly computer model has been developed that enables irrigation water users to plan the amount of irrigation water required by an irrigation farm, an irrigation scheme or a water management area on a month by month basis. This tool, SAPWAT, first published in 1999. It was a further development of CROPWAT and has eventually been used by more than 300 users in 13 countries, even though it was designed against the background of South African needs. SAPWAT was continuously improved and upgraded, with the newest version published as SAPWAT3 in 2008. SAPWAT3 is based on FAO Irrigation and Drainage Paper no 56, "Crop Evapotranspiration", which reflects the international thinking on the standardization of approaches to irrigation water requirement planning.

SAPWAT3 is designed for maximum user interaction, an approach which contributes to the user's understanding of issues affecting good irrigation water planning and management. This approach has the added benefit that SAPWAT3 serves as a good training and demonstration aid.

SAPWAT3 is not a crop growth model. It is designed to allow the user to imitate through interaction the situation in an irrigated field. This allows the user to do "what if" with different irrigation scenarios to see what the effect of a specific management decision is on irrigation water requirement.

SAPWAT3 is:

- The program is designed as a shell within which the user has full data management facilities so that each user can add, edit or deletes data as required. Provision is made for electronic importation of big data sets, such as weather data, from a variety of sources such as CLIMWAT, FAO New_LocClim and others.

- Data is stored on-board because it was found that a significant number of SAPWAT3 and potential SAPWAT3 users do not have easy access to Web-based data sets, especially not during farm visits where access to the web might be limited.

- Weather station and weather data include monthly data similar to CROPWAT; the complete CLIMWAT for CROPWAT weather data set have been included in SAPWAT3; as well as up to fifty years of daily data in 5100 weather station data sets. This allows

SAPWAT3 to be used internationally. Daily data for any number of successive years is used to do year-on-year irrigation requirement estimates, the result of which allows the user to include risk analysis as part of the planning process.

- The 104 crops included in the crops data set have been expanded to 2500 crop records by providing for differences in growth and development because of planting different cultivar types at different times of the year and in different climates. This was done because irrigation system and irrigation reticulation system designers and planners did not necessarily have background knowledge on the effect of these elements on crop growth and development, with the result that wrong design decisions were sometimes made.

- Irrigation strategies can be varied to demonstrate the effect of different strategies on irrigation requirement. This allows the user to devise irrigation strategies that will aim at maximizing rainfall use efficiency and thus reduce irrigation water requirement.

- Salinity stress and water stress situations can be imitated. This module works from two sides. The effect of stress on yield is displayed, or the user can also define a level of yield reduction in order to stretch his water. If a yield reduction is defined, the program will apply water stress so that yield reduction reflects the level aimed for.

- All irrigation requirement estimates can be stored and revisited to determine what effect changes in irrigation water management, irrigation system and changes in planting dates could possibly have.

- The editing functions of weather stations allows the user to adapt data to represent predicted climate change scenarios which can be used to predict irrigation water requirements under climate change situations. “Now-then what-if” scenarios could be set.

- Data can be exported for use in other applications such as for use in spreadsheets.

- A link is provided for doing enterprise budgets parallel to the irrigation requirement estimation so that planning can cover both irrigation requirement and financial results.

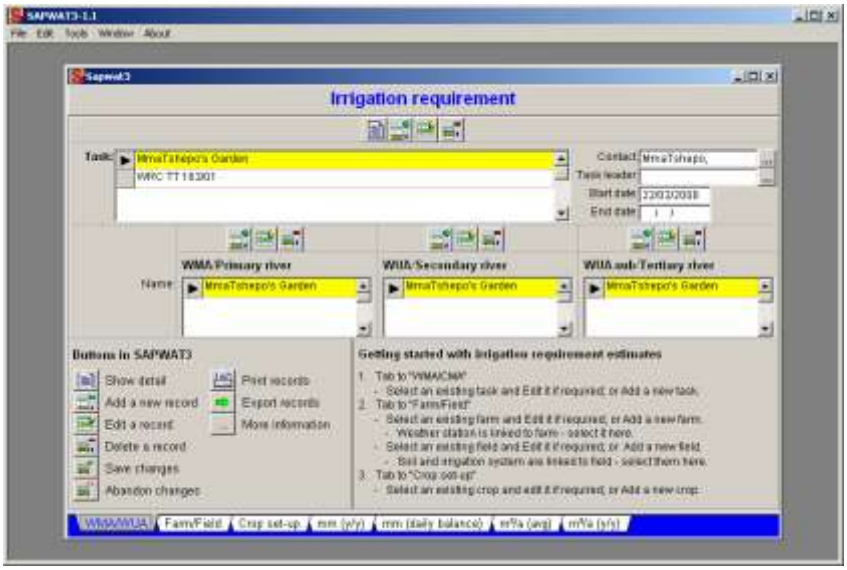
- A module for small (back-yard) water harvesting situations where the amount of water required for a small garden can be estimated. Runoff from roof and/or adjacent hard-packed surfaces and storage requirements are determined. Maximum garden size for balance with harvest area and storage is calculated. Pumping times with low technology pumps such as the treadle pump is also calculated.

- Large data sets can safely be handled. The weather data records amount to about 38 million records.

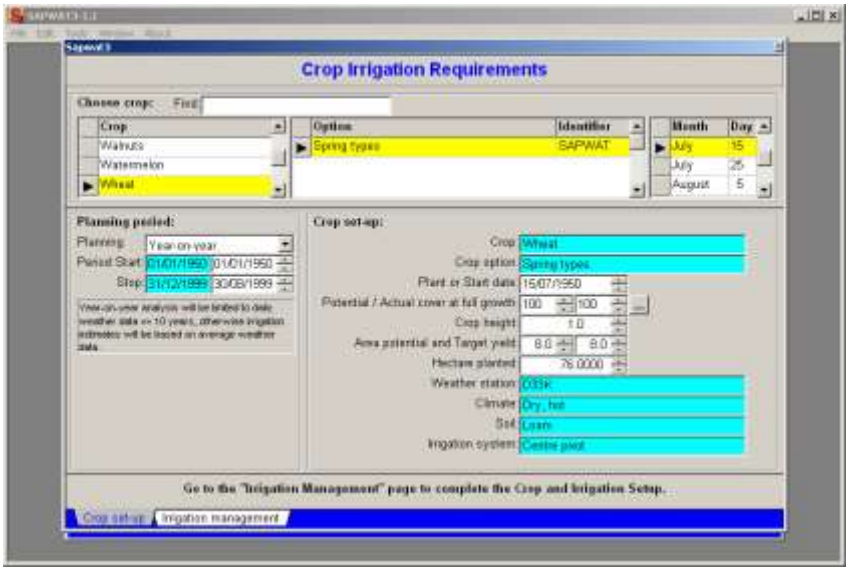
Introducing SAPWAT3

The program provides the user with the ability to manage all the background data that is used by SAPWAT3. These include crops, irrigation systems, soils, area water distribution systems, weather stations, enterprise budgets, countries, and an address list. Köppen climate definitions are also given, but these are read-only.

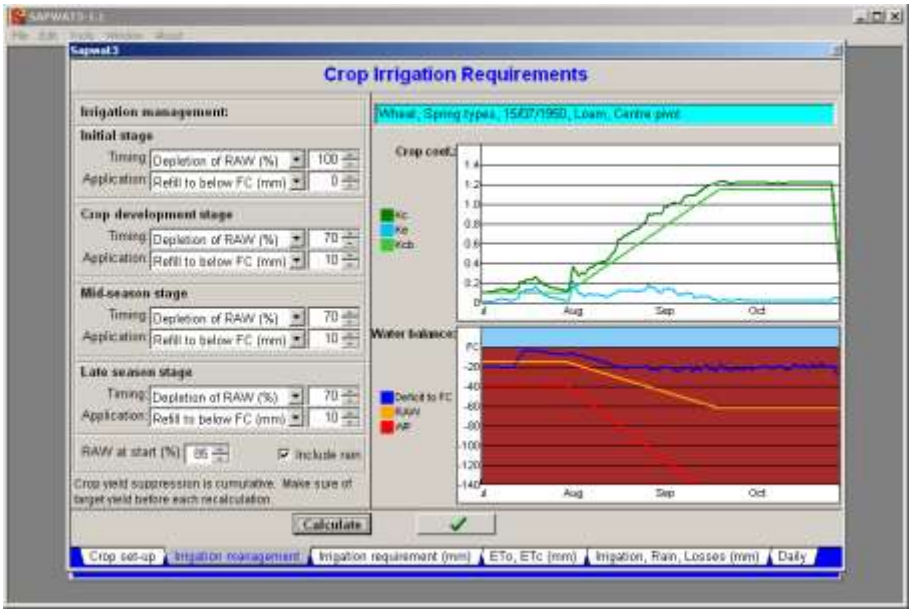
The user does an area, farm, field, crop set-up to reflect the area that he works in. Provision is made that back-wards summation from crop irrigation requirement to field, farm and area irrigation requirement. The efficiencies of irrigation water reticulation systems at different levels are included in this calculation.



The crop for which irrigation requirement needs to be estimated, is defined in terms of weather stations and climate, soil type, irrigation system, planting date, foliage cover, yield, area planted and irrigation management strategy. For year-on-year irrigation requirement estimates, subsets of the weather data, such as a period that is known to have had a below average rainfall, can be selected.

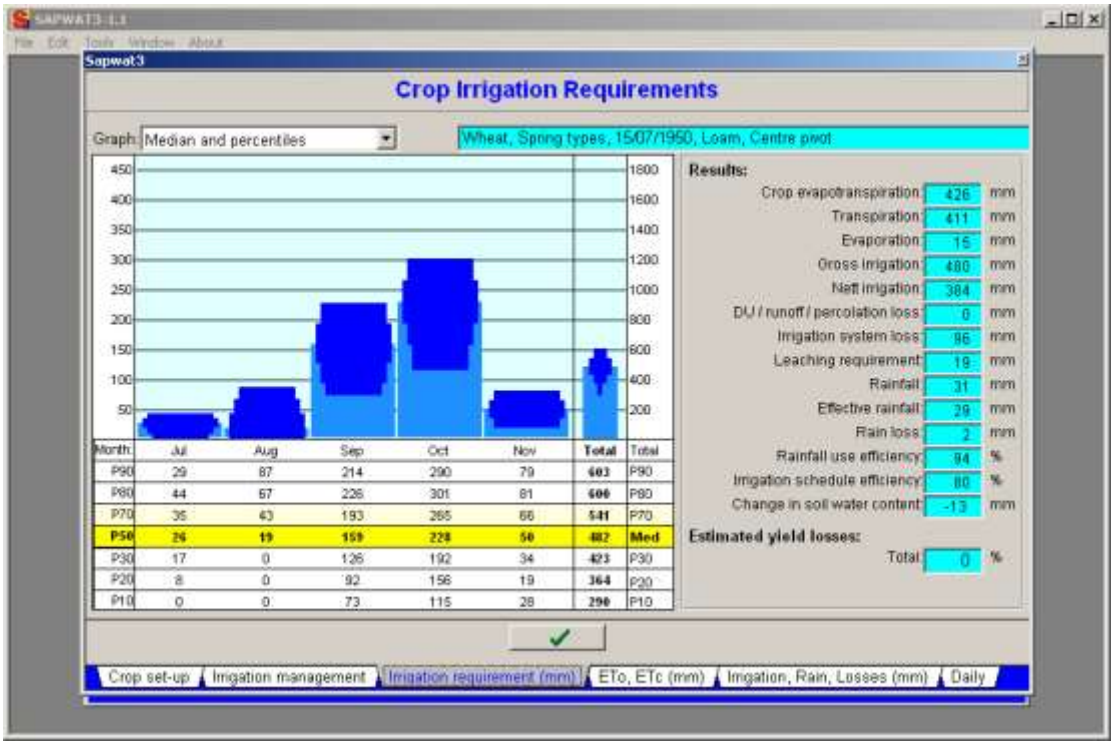


The results are graphically displayed as crop coefficient, evaporation, and crop evapotranspiration as well as soil water content over the growing season.



Further results show monthly and total irrigation water required for different levels of non-exceedence, as well as levels of efficiency of irrigation water use and rainfall use efficiency.

Further results show irrigation requirement on a year-on-year basis in mm as well as cubic meters for the area planted. Daily water balances can be inspected, specifically for identifying water stress situations.



Saving water with SAPWAT3

SAPWAT3 is used by all irrigation designers in South Africa to optimize water use to its fullest extent. A variety of answers is possible depending on an irrigation strategy selected. One such case is short grower maize planted on 15 December. If the irrigation strategy is to make best possible use of rainfall by not filling the soil profile to field capacity during irrigation, irrigation water required is 320 mm. If the irrigation strategy is changed to always fill the soil profile to field capacity, which results in low rainfall use efficiency, irrigation requirement is 500 mm. Irrigation water saving by using the better strategy amounts to 180 mm, or 36%. If this saving is translated to the 1.5 million hectares irrigated in South Africa, total annual irrigation water saving could amount to 27 000 Mm^3. Water saving has been achieved in a number of Water Management Areas and due to this officials of the Department of Water Affairs are using this this quantify to optimum amount of water for a specific command area.

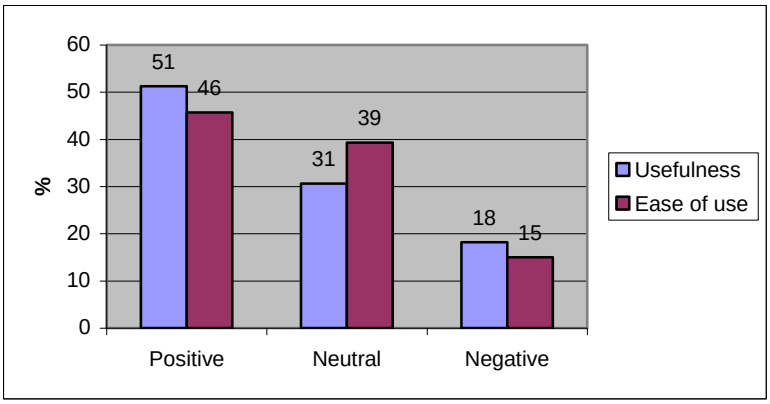
Introduction and distribution of SAPWAT3

SAPWAT3 is printed as a report plus DVD by the South African Water Research Commission as report no TT391/08. More than 350 copies have been distributed to date. Some distribution was through demonstration and training visits to irrigation areas by the nominees, but most of the distribution is on request by interested parties to the Water Research Commission. Distribution inside South Africa is free of charge.

Apart from application in South Africa, SAPWAT3 has been used in Angola, Mali, Mozambique, Namibia, Niger, Swaziland and Uzbekistan for design of irrigation systems and for irrigation water use planning.

Acceptance of SAPWAT3 as an innovation

The SAPWAT3 has been fully endorsed by the Department of Water Affairs in South Africa as a tool to issue water licenses for irrigation purposes. A survey amongst users about one year after publication shows that 51% found it a useful tool and that 46% found it easy to use. The values for neutral seem high at 31% and 39%, but judging from comments from users, most of the neutral group has not had time to gain enough experience in the use of SAPWAT3 to allow unbiased judgment, and therefore they marked the relevant questions on perceptions as neutral.



Scope for further expansion

SAPWAT3 is continuously being upgraded as newer information becomes available. A further development includes a module that will allow the user to evaluate the correctness of crop coefficients in order to be able to use more accurate crop growth and development data.

Requests to include the facility to do smaller scale irrigation dam water balances in order to manage such dams have been received from a number of SAPWAT3 users.

Experience by irrigation system designers and irrigation water planners suggests that SAPWAT3 can be used to advantage for such planning and design in the rest of Africa.

Roles of individual nominees

The nominees' foresight by planning and designing a tool like SAPWAT3 is commendable. This tool play a major role in reducing irrigation water requirements through demonstrating and teaching more efficient water use in South Africa. This is achieved by:

- Reducing irrigation water requirement and thus free up some water for domestic use in areas with known water shortages;

- Making irrigation water available for growing more crops that will be required to feed a growing population.