IMPROVED WATER USE ONLY A SATELLITE AWAY

Sugarcane growers in one of the country's most overexploited catchments will soon have the aid of cutting-edge satellite technology to improve their water-use efficiency and up their production. Article by Lani van Vuuren.

When travelling through the Inkomati area, in Mpumalanga, one cannot help but notice the rich variety and quality in produce grown. Bananas, citrus and sugarcane are but some of the products providing a feast for the eye for kilometres on end. However, while this might fool one into thinking that the area is as rich in water as it is in crops this is simply not the case. In fact, Inkomati is one the most water-stressed catchments in the country, with many users, including towns and villages, the Kruger National Park and South African neighbour Mozambique and Swaziland, vying for their share.

Escalating demand from expanding rural settlements, the need to meet environmental requirements as well as the obligations to the country's downstream neighbours, means that the catchment's largest water user – irrigated agriculture – is under pressure not only to improve water use efficiency to free up resources for other sectors, but also to expand its own operations to allow it to feed a growing nation.

INNOVATIVE TECHNOLOGY

A new project co-funded by the Water Research Commission (WRC) and the Department of Agriculture, Forestry & Fisheries will assist specifically sugarcane growers in the region to do just that and more through the application of the latest remote sensing technology, which uses satellite data to measure fundamental evapotranspiration and growth processes.

Fancy words, but how does it work? Project leader, Dr Caren Jarmain from the University of KwaZulu-Natal explains: "Basically, remote sensing simply refers to the capturing of information from a distance, in this case satellites. The satellite takes a picture more or less in the same way as a camera does as it moves over an area, except it captures much more information than is visible to the naked eye, specifically also thermal infrared and near infrared information, which is what we are interested in." This is because the temperature of a crop or plant often reflects the stress it experiences at a given time. Just as a person perspires to cool down, when plants transpire actively, their temperatures are lower (i.e. stomata open) compared to plants experiencing stress (stomata closed).

A number of algorithms have been developed over the years that use a combination of this type of satellite data along with extrapolated field data (from local weather stations) to estimate evaporation from a surface (in some cases, equivalent to crop water use). The research team will specifically be applying the SEBAL (Surface Energy Balance Algorithm for Land) model, which has been well established in water resource management internationally and tested successfully during a pilot project involving grape farmers in the Western Cape (the so-called GrapeLook project).

The WRC has in the past invested in research to measure and model crop water use. However, it is suggested that further investigations should be conducted in South Africa to conclusively confirm the accuracy of remote sensing when compared to established methods of estimating crop water use, such as SAPWAT.

The project team will specifically focus on assessing crop water use (i.e. transpiration) of the sugarcane, but also on the water use efficiency (or crop water productivity), in other words, how much produce is produced per unit of water. "In this area different irrigation systems are used, including pivot, dripper and overhead systems. One can use this type of information to assess if any improvements can be made in terms of the use of water," explains Dr Jarmain.

INFORMATION AT YOUR FINGERTIPS

At the time of writing a website was being established specifically for the project to be up and running by October this year. Data maps will be placed on the site at a weekly interval along with related information such as rainfall, evaporation, evapotranspiration deficit

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Sugarcane is one of the major crops of the water-stressed Inkomati catchment.

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Above: *Sugarcane from the Inkomati basin contributes to nearly 20% of total sugar production in South Africa.*

Below: *Young shoots of sugarcane standing under irrigation outside Malelane, in Mpumalanga.*

(the difference between evaporation losses and the potential evaporation of the crop), crop production (biomass) and derivatives (rainfall minus evaporation). Organisations participating in the research, including farmers, irrigation consultants and the catchment management agency, will be able to assess how much water was used by the sugarcane over a week period in relation to the irrigation applied by the farmer.

"Uniformity of evaporation losses over an irrigation block can be assessed using the data and adjustments made," notes Dr Jarmain. "The evapotranspiration deficit data, in turn, can be used to determine if plants in a specific block are experiencing any water stress and adjustments to irrigation systems and/or applications can be made accordingly. The fact that all information is provided spatially is very valuable, since farmers generally strive towards uniformity over an irrigation block."

There are several challenges in this regard, firstly the timely delivery of good quality (i.e. cloud-free) remote sensing data. "For an operational system to deliver information at a weekly time-step, a good quality image needs to be captured each week and be delivered soon after data capture so that the processing can be performed in time," explains Dr Jarmain. The project also hopes to promote this approach, and therewith gain participation, from as many sugarcane farmers as possible.

TSB Sugar, one of the leading producers of sugar in the country, has already confirmed its support for the project. According to Dr Pieter Cronjé, Manager: Grower Affairs, it is hoped that this technology will contribute to highlighting areas requiring more attention. "The northern sector of the sugar industry is highly dependent on irrigation, and any system that can assist in the strategic management of a scarce resource will contribute to sustainability. The Inkomati area also features some large estates where production is monitored very thoroughly, and the space-based system will enable managers to pin-point inefficiencies more accurately while explaining lower than expected yields, thus guiding management interventions."

Dr Cronjé explains that the optimum production of sugarcane requires a significant amount of water. Water use measurement among sugarcane farmers in the area vary from no measurement at all to remote sensors with data logging and transmission to a central point. Unfortunately, irrigation is still mostly based on irrigation systems' design capacity rather than might be required by the plant or soil at any given point in time. "As a result we have experienced gross over-irrigation on several farms. TSB Sugar has been running an awareness campaign in this regard for several years. Where proper irrigation scheduling has been applied, production has improved up to 15%. We anticipate that the WRC project will further aid

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in highlighting these inefficiencies and lead to a better management system."

ENHANCING CAPACITY

From a research point of view the project has several important aims, firstly to present this novel technology to South African irrigation farmers. Dr Jarmain is of the strong opinion that this technology has the potential to assist farmers to improve their production, however, cooperation is required between farmers and researchers to ensure that the information is presented in a way that is most useful.

At the same time, very little expertise in this technology in South Africa currently exists, and the project will be exposing students to this type of remote sensing and its potential for water management in South Africa. Lastly, Dr Jarmain notes that many national departments can benefit from data generated using this type of technology. "Illustrating to the departments of Water Affairs as well as Agriculture, Forestry & Fisheries how this type of information can be used can greatly increase the use of this type of data. This obviously relates directly to capacity building."

A similar study is also being planned for irrigated grain crops in the Middle-Orange River catchment as part of this project. The WRC project is also set to benefit from an upcoming European Union study, WATPLAN, which will be conducted simultaneously in the Inkomati catchment. This research project is aimed at integrated SEBAL estimates of crop water use to catchment scale, thereby ensuring that international obligations in terms of water delivery and management, is met.

Remote sensing technology will only improve over time in terms of how many satellites are available, how frequently data is captured, at which resolution data is captured and the costs at which the data is made available, maintains Dr Jarmain. "Hopefully in a few years' time satellite constellations will be available that can capture data daily at high resolutions, finer than the frequency currently used (30 m by 30 m)."

NATIONAL IMPORTANCE

For a large country such as South Africa, with huge variations across the landscape this technology can really add value not only for determining water use of agricultural crops (dryland and irrigated) but also of invasive alien plants, natural veld and forestry, to name but a few. Data can be shown in the form of maps or integrated at field, farm, region, catchment, province or whichever scale is required. 'Water accounts' can also be determined at different scale, especially catchment level.

It is clear that the application of this technology has far greater potential than just improving crop production, as WRC Director: Water Utilisation in Agriculture, Dr Gerhard Backeberg, points out: "The last reliable assessment of the area of different crops under irrigation in South Africa was published by the WRC 15 years ago (**WRC Report No: KV96/96**). It is important to determine the current area under irrigation, cropping patterns and water use across all farming types and irrigation schemes. In order to improve the efficiency of consumptive water use it is essential to increase beneficial crop transpiration and limit non-beneficial soil evaporation within the water balance. By achieving this, the productivity, competitiveness, profitability and sustainability of food production under irrigation will improve."

"The accessibility of satellite images ensures data flow on changes in water use. The most important benefit is to monitor how changes in land use and consumptive water use affect water availability in different catchment areas," Dr Backeberg continues. "In addition, a data platform is generated with a range of applications. This, in turn, creates opportunities for service providers such as irrigation scheduling and soil fertilisation advice, plant disease and electricity cost control. Apart from more productive agricultural water use, many new business and employment opportunities will therefore arise in rural economies."

Readers interested in participating in the project, Water Use Efficiency of Irrigated Agricultural Crops Determined by Satellite Imagery (**WRC Project No: K5-2079**) can contact the Editor for further information. ❑

THE SOUTH AFRICAN SUGAR INDUSTRY

South Africa is one of the world's leading producers of high-quality sugar, with about 35 300 registered sugarcane growers farming predominantly in KwaZulu-Natal, Mpumalanga and the Eastern Cape.

Sugar is manufactured by six milling companies with 14 sugar mills operating in the main cane-growing regions. The industry produces about 2,2 million tons of sugar per season, of which 60% is marketed in the southern African Customs Union. The remainder is exported to countries in Africa, Asia and the Middle East.

The sector makes an important contribution to the local economy, and directly employs around 77 000 people – this represents a significant percentage of the total agricultural workforce in the country. When considering those indirectly employed by the sector it is estimated that about one million people in South Africa depend on the sugar industry for a living.

Source: South African Sugar Association