INDUSTRIAL WATER

A decision support tool for industrial water reuse in South Africa

A CSIR project is developing a decision support tool to increase the reuse of water in South African industry. Article by M Steyn, B Genthe, I Banoo, M Thwala, T Roos, C Walters and F Ramakhwatho.

Water scarcity, increased pollution, unprecedented population growth and climate change are all driving the need to reuse water to secure the future of the country. It is clear that South Africa's already strained water resources will become even more stressed in the near future. The Department of Water and Sanitation (DWS) (2017) predicts that by 2030 water demand will reach 17.7 billion m^3, far more than what is available to allocate. Responsible and efficient water management is fast becoming a pressing reality for domestic users, agriculture and industry alike. The challenge is therefore to do the most with the little water we currently have.

The water use per sector according to the latest National Water and Sanitation Master Plan (DWS, 2018) is depicted in Figure 1. The main water users in South Africa are agriculture (61%) followed by domestic water use (27%) and Industry (7%). Figure 2 represents a breakdown of the main industrial water users in South Africa (Cloete et al, 2010).

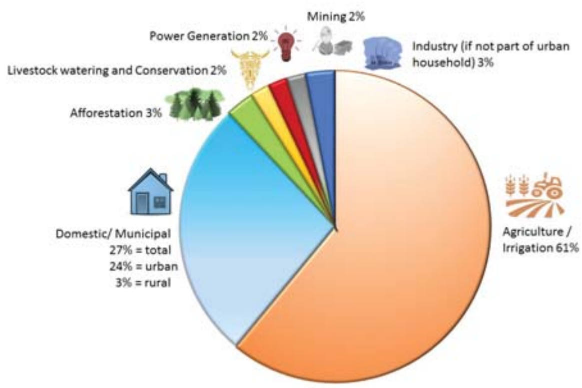

Figure 1: Water use per sector in South Africa (DWS, 2018).

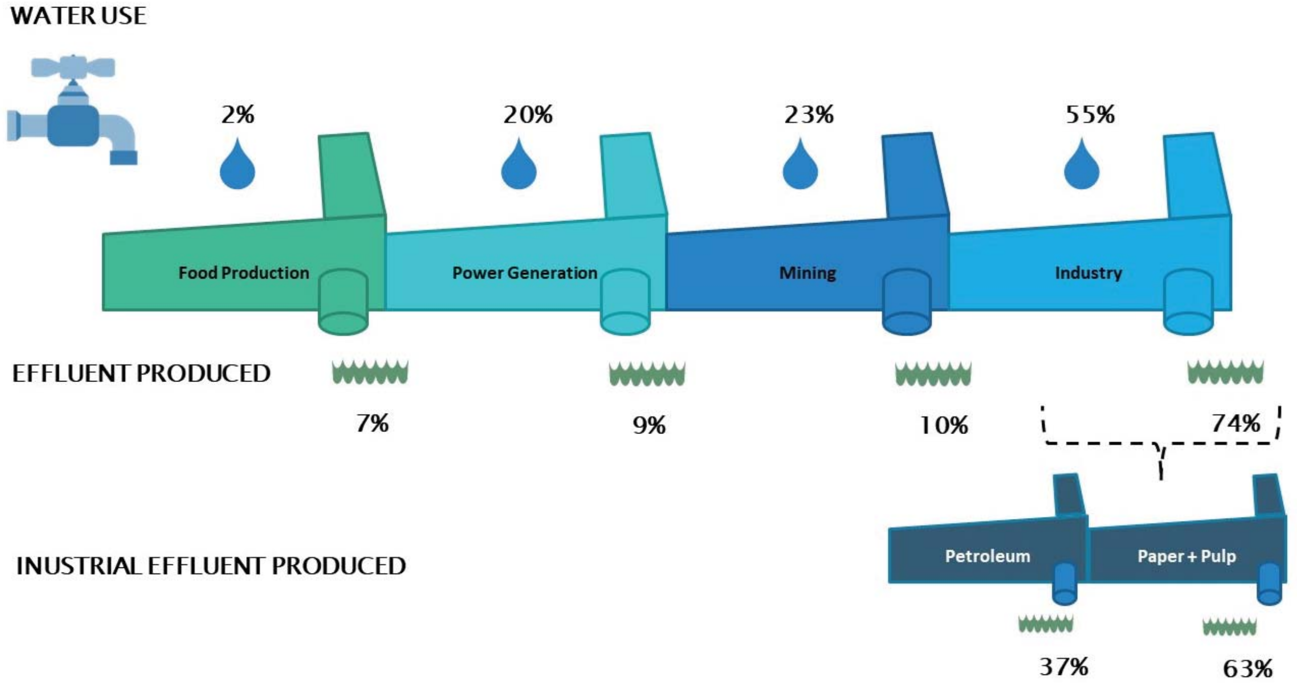

Figure 2: Industrial water use and effluent production in South Africa.

Various types of water can be reused and, depending on the intended use, the wastewater may require treatment prior to reuse, and may either be treated to potable or non-potable standards. Water reuse can occur at a variety of scales, including onsite reuse where the water is reused at the same site where it was first used. Indirect reuse is where treated wastewater is returned to local water resources and is later abstracted and reused by downstream water users. An example of direct reuse of treated effluent delivered directly to an industrial water user is Mondi Paper in the southern part of eThekwini municipality receives treated domestic effluent from the Southern Wastewater Treatment Works, freeing up sufficient drinking water for approximately 300 000 people (eThekweni Municipality, 2011).

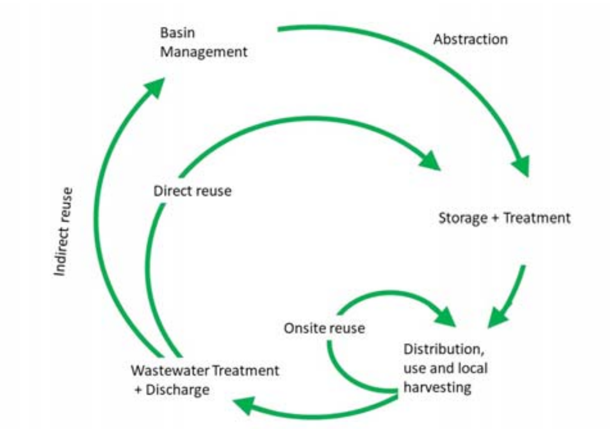

Figure 3: Scales of water re-use (adopted from Green Cape, 2018).

Treated domestic wastewater has long since been reused for various purposes, such as irrigation of sports fields and crops as well as for reclaimed drinking water (e.g., Atlantis managed aquifer recharge plant). More recently wastewater has been treated and used directly for drinking (e.g., Beaufort West).

While there is still much more that can be done with domestic wastewater, the value of industrial effluent is yet to be realised globally. This is shown in the GreenCape's Market Intelligence Report (2018) where the total Gross Value Add (GVA) for moderate and highly water intense users in the Western Cape Province in 2016, excluding agriculture, was calculated to be R155 billion (Quantec 2017).

An assessment of the industrial effluent reuse potential of the country will assist in identifying where water can be made available for development. Industrial companies are increasingly exploring the reuse of their effluent (wastewater) streams. Internationally, there is a general move towards zero liquid discharge, and several industries in South Africa already reclaim and reuse significant amounts of wastewater, such as the mining and sugar sectors.

In June 2018, Nestlé South Africa announced the launch of its R88 million zero-water dairy manufacturing facility in Mossel Bay, in the Western Cape. It was estimated that the facility would allow Nestlé to reduce the factory's water consumption by more than 50% during the first year of implementation by reusing the water recovered from the milk evaporation process, saving 168 million litres of water a year. It is estimated that Nestle will eventually reduce its municipal water consumption to zero (Engineering News, 2018).

As part of its new organisational strategy, the CSIR intends to become increasingly responsive to support the country's industrial development needs. A three-year CSIR project funded by Parliament aims to assess the feasibility of reuse and recycling of industrial effluent to augment national water resources. The CSIR project team, led by Bettina Genthe from the Integrated

Water Analytics and Solutions research group, is working on a national decision support system to assist metropolitan municipalities, and decision makers within these municipalities, to identify possible sources of industrial effluent available for reuse.

One of the project objectives is to evaluate a toxicity bioassay toolkit that could assist with the decision making. In terms of water quality and potential risks, effluent is seldom treated or tested beyond a few basic chemical parameters. This project therefore aims to identify and test a number of bioassays and to recommend a battery of bioassays to assess water quality for reuse potential. Based on effluent quality the reuse of the effluent might only be suitable for specific uses and these will be identified based on lab testing with such assays.

The Mondi Paper example described earlier provides a real-life example of where industrial effluent produced by one industry is directly reused by another industry. The CSIR project team visited some of these industries to learn more about what has been done to date and the CSIR team is currently working with these industries and the metropolitan municipalities to identify other possible examples and potential pilot sites.

The electronic decision support system will provide information on industry location via GIS maps. The maps will display the volumes of water consumed as well as the volumes of effluent produced in each location. Effluent quantities will be logged once received from the metros. To date, the project team made use of publicly available data. The team identified locations (GPS coordinates) from Natsurv documents (an example of this is shown in Figure 4) and mapped the industry data on GIS maps. From there the team made use of the publicly available WARMS (Water use Authorisation & Registration Management System) data that provides data on the licensed use of water in each municipality. By overlaying the industry location and industrial water uses, the team could identify available effluent volumes and quality for reuse by other industries.

The project team has further engaged with stakeholders in the latter phase of the project, and is awaiting data from metros on the actual water use and effluent volumes produced in the respective areas. This will validate the WARMS data, which is based on licensing and not a true reflection in all cases of actual volumes used and effluent volumes produced or its availability for reuse. In cases where industries are already reusing their own effluents, the team will also produce a map of existing case studies and where effluent is not available for reuse.

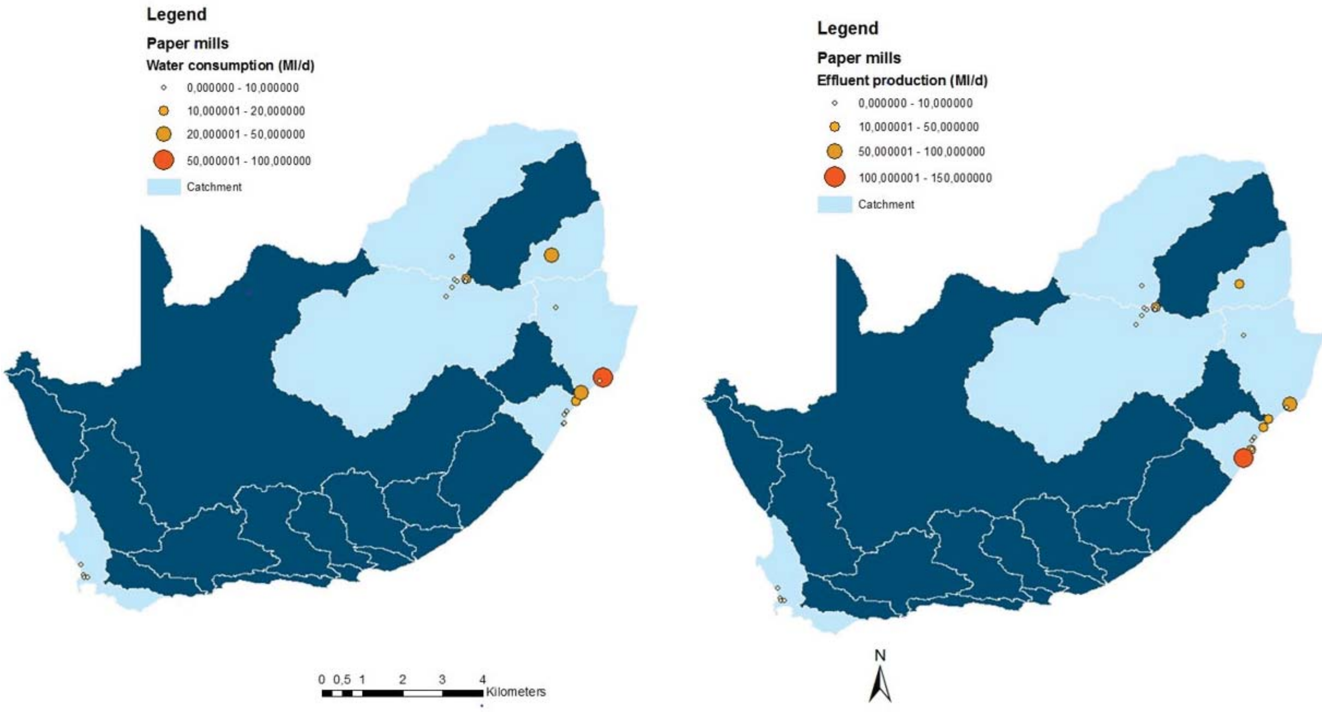

Figure 4: Water volumes consumed and effluent volumes produced by paper mills in South Africa.

Figure 4 is an example of one of the maps produced by the team which highlights the location and water consumption volumes of paper mills in South Africa followed by the effluent volumes produced by each of these paper mills. Higher volume consumption of water or higher effluent volumes are indicated with darker and bigger circles. It is envisaged that the final decision support tool will have clickable links for each registered industry. The user can then click on the map or a specific area to view further information about the effluent qualities, volume and availability as well as the reuse compatibility for specific industries based on effluent qualities and distances to other industries. Transport of effluent over large distances is often not feasible due to additional costs and risk (e.g. spills and accidents).

Reused water can play an important role in water security in a water scarce country such as South Africa as it can augment or partially substitute freshwater resources needed for domestic purposes and future development. Van Niekerk and Schneider (2013) caution that receiving water quality objectives must be clearly defined and the impact of reuse on water quality must be carefully managed and that in some instances, more advanced treatment may be required to further encourage reuse. During the next phase of the project, the toxicity bioassay information for certain effluent qualities will be finalised to help municipalities identify possible reuse opportunities. The tool will be ground-truthed by the municipalities and further improved by accurate data. As a final output, the team plan to publish a national industrial water reuse atlas for South Africa.

It is envisaged that in future, cost estimates or savings for reusing effluent compared to extracting potable water can be added to the decision support system for further decision making. Such a tool will be very handy, especially if a possible day zero scenario (WWF, 2019) happens in future. Decision-making would be easier and faster and could be based on potential cost savings.

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