POLICY BRIEF

September 2017
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Water footprint assessments for fruit and vegetable crops

A recently completed Water Research Commission (WRC) project has calculated the water footprints of selected fruit and vegetable crops, and evaluated the usefulness of this approach in assessing water use. The research revealed vast differences between water footprints as a result of crop species, growing conditions, inter-annual climate variation, and the growing season in which the crop was cultivated (spring, summer, autumn or winter). The study suggests that, at this stage, water footprints for crop products are not suitable as an awareness-raising tool for consumers due to the many variables and complexities influencing them, and the trade-offs involved in sustainable water use. However, product labels featuring a symbol that indicates good water stewardship, combined with supporting education, advertising and government subsidies, could assist consumers in making wise decisions on their water use.

Background

As a water-scarce country that has yet to achieve equitable access to water, South Africa stands to benefit from any information that could guide improved water management. Water footprints as a means of assessing water consumption have gained worldwide attention since the concept was created by Prof Arjen Hoekstra of The Netherlands in 2002, and have been calculated for a variety of South African products and businesses. A previous WRC project (**TT 616/14**) reviewed the applicability of water footprints in South Africa, and identified several potential benefits as well as shortcomings of the approach.

The latest WRC project evaluated different water footprint methodologies for use in an agricultural context, where a water footprint represents the volume of water required to produce a certain mass of crop yield. Two case studies were used to determine water footprints for important fruit and vegetable crops, and to upscale these to catchment level.

The first case study focused on the Steenkoppies Aquifer near Krugersdorp in Gauteng, where water footprints were calculated for carrots, cabbage, beetroot, broccoli, lettuce, maize and wheat, these being the main crops cultivated in the area, typically under pivot or sprinkler irrigation.

The second case study focused on apples and oranges grown in the 89 quaternary catchments making up the Olifants-Doorn component of the Berg-Olifants Water Management Area in the Western Cape.

Water footprint methodologies

The original method of calculating water footprints was criticised in some quarters, and new methods were developed by various scientists. Today, there are three main approaches applicable to agricultural assessments.

- **The Water Footprint Network (WFN) approach** is the original methodology, and entails estimating 'blue', 'green' and 'grey' water footprints. In a crop production context, the blue water footprint is the volume of water abstracted from rivers, dams and aquifers for irrigation, while the green water footprint is the amount of rainfall stored in the soil until it evaporates or is taken up by plants. The grey water footprint represents the water required to dilute pollutants, such as nitrogen-rich fertilizer, to ambient levels. The overall water footprint thus accounts for both water quality and quantity impacts.

- **The Life Cycle Assessment (LCA) approach** aims to assess the water use impact of a product or process 'from cradle to grave'. It only includes a blue water footprint, and uses a Water Stress Index (WSI) to adjust this footprint to local conditions. The WSI can either be obtained from a database of regional WSI values for the entire globe, or calculated in more detail for a specific area of interest. The results are reported as 'water equivalents' (H2O-e), which may be difficult for non-specialists to understand, but an advantage of the approach is the ability to include other environmental impacts, such as the carbon footprint, eutrophication, freshwater ecotoxicity, aquatic and terrestrial acidification, and human health. The water footprint standard ISO 14046, published in August 2014, aligns most closely with the LCA approach.

- **The Hydrological-based approach** considers all components of the water balance, rather than only water consumption. It accounts for net changes in soil water and groundwater over a hydrological year to estimate blue and green water footprints, and uses the same approach as the WFN method to estimate grey water footprints. In the case of irrigated crops, a negative blue water footprint is possible if the replenishment of the water resource through return flows and precipitation exceeds water use for irrigation. A negative footprint is in fact required to sustain groundwater-dependent ecosystems, where groundwater recharge over the year must be higher than the volume abstracted. However, negative footprints are likely to cause confusion, and the approach is difficult to apply to hydrologically complex systems.

These different approaches were compared using data generated within the Steenkoppies Aquifer case study. Each was found to have strengths and weaknesses, depending on the specific aim of the assessment. Water footprint assessments can measure the volumes of water utilised by humans, indicate the sustainability of water uses, or provide a tool to manage and increase efficiency of water uses.

The project team concluded that blue and green water footprints of the WFN methodology are the most useful for a number of reasons, but particularly because they are relatively simple to calculate and understand.

Potential uses of water footprints

In a South African agricultural context, water footprints have the potential to provide information for water management on a national, regional and local scale.

Water footprints could be useful for informing policy formulation and integrated resources management at the **national** level. For example, to ensure food security it may be justified to import certain fruit and vegetables with high water footprints from countries where water is more abundant, rather than growing them in South Africa, especially as water becomes an increasingly scarce resource.

Water footprints could increase understanding of water-related risks and assist with water allocation and management at the **regional** level. For example, calculating water footprints for all crops grown in a catchment or on an aquifer would provide information on the overall water requirement of irrigated agriculture there. Comparing these water footprints with crop yields would facilitate cost-benefit analyses for the various crops, and allow for improved monitoring of water use.

Water footprints could help in identifying opportunities to reduce water consumption or its impact at the **local** level. For example, farmers could use water footprints to determine which crops in the different seasons will provide the best yields when water limitations and allocations are enforced. Alternatively, they could determine which crops will provide the highest income or nutritional value with a certain volume of water.

Complexities of water footprints

Unlike a carbon footprint, where an activity that releases CO_2 will have an equal effect on the global atmosphere irrespective of where that activity takes place, the water footprint associated with an activity will differ from one region to another. For example, using one liter of water in the Nama Karoo might have a much greater impact on the environment than using one liter of water in the Eastern Cape.

Apart from regional effects, the research revealed vast differences between water footprints as a result of crop species, growing conditions, inter-annual climate variation, and the growing season in which the crop was cultivated (spring, summer, autumn or winter).

In addition, water footprints that are calculated according to fresh mass of the product result in disproportionally high water footprints of crops with low water contents, such as maize and wheat, compared to crops with high water contents, such as vegetables. The water footprints become more similar if calculated according to dry matter.

Importantly, water footprints are only as good as the data on which they are based. Using regional estimates for solar radiation in crop models, for example, might give significantly different outputs compared to using accurately measured weather data.

Water pollution from non-point sources, such as runoff and leachate from farmlands, is much more difficult to quantify than point-source discharges typical of industry. Pollutants associated with crop production include nitrates, phosphates, salts, sediments and pesticides. Assessing their impact on water quality using the somewhat simplistic approach to calculating grey water footprints is not considered appropriate or practical for the South African agricultural context.

Conclusion

Although water footprints can provide useful information, there are challenges involved in calculating them, as well as interpreting the information in light of the ecological and socio-economic environment, and knowing how to respond accordingly.

Furthermore, conducting a water footprint assessment for a product or process entails data collection that in itself has the potential to increase understanding of the system and improve its management. The degree of value added by determining a water footprint requires further exploration.

Water footprints for crop products are currently not suitable as an awareness-raising tool for consumers due to the many variables and complexities influencing them, and the trade-offs involved in sustainable water use. However, product labels featuring a symbol that indicates good water stewardship, combined with supporting education, advertising and government subsidies, could assist consumers in making wise decisions on their water use.

Further research on water footprints of fruit and vegetable crops is warranted, and the project team have made a number of recommendations in this regard. In addition, WRC projects investigating the water footprints of other crop types are currently in progress.

To order the report, ***Application of water footprint accounting for selected fruit and vegetable crops in South Africa*** (**Report No. TT 722/17**), contact Publications at Tel: (012) 761-9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.