THE WATER WHEEL

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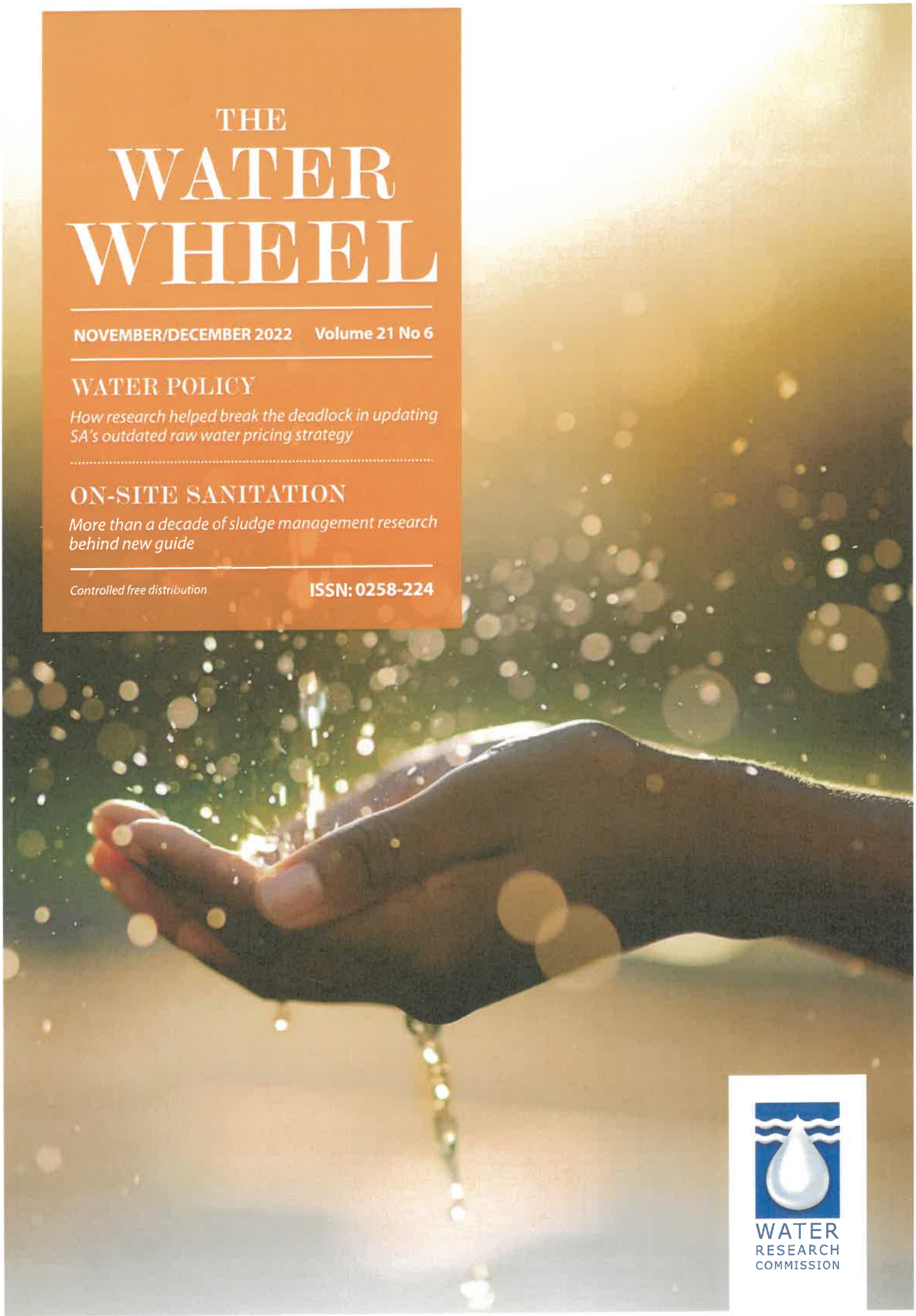


WATER RESEARCH COMMISSION

INVASIVE ALIEN PLANTS

MAPWAPS
MAPPING WOODY INVASIVE ALIEN PLANT SPECIES

New project aims to map alien invasive trees

A project supported by the Water Research Commission (WRC) aims to map invasive alien trees and their impacts in key strategic water source areas. Article by Alanna Rebelo, Karen Esler and David le Maitre.

The WRC is funding a project which aims to map woody invasive alien plants and their impacts in four key strategic water source areas. Strategic water source areas are those which supply a disproportionately large amount of water relative to their area. Called MAPWAPS for short, this project was launched on 1 April 2022 and will run for three years until March 2025.

The project aims to use freely available satellite imagery and cloud computing to map alien trees in some of the strategic water source areas that do not have recent information on biological invasions and their impact.

The project team is led by Dr Alanna Rebelo of the Water Science Unit at the Agricultural Research Council – Natural Resources and Engineering, along with collaborators Profs Karen Esler and David Le Maitre of the Conservation Ecology and Entomology Department, Stellenbosch University, and an MSc and PhD student that will be trained on the project. They will study which techniques work best in particular biomes for detecting alien trees and quantifying their impacts on water resources.

Why do we need to map invasive alien trees?

Alien tree invasions are known to be highly problematic in South Africa, causing damages estimated to amount to billions of Rands annually. According to Van Wilgen and Wilson (2018), Government alone spends millions of Rands (close to a billion) annually on managing alien tree invasions.

The main reasons that alien tree invasions have such negative impacts on society are related to water, fire, soil, carbon and biodiversity.

Alien trees are known to use more water than our indigenous South African vegetation, resulting in a reduction of our already scarce water resources. These results are well understood in South Africa, first being measured for plantations in paired-catchment experiments that began in the 1980s, and since then confirmed by various other empirical and modelling studies, such as those of Le Maitre et al. (2016).

Alien trees, because of their large sizes, also result in higher fire intensities and increased fire risk due to softening boundaries between fire-prone wildlands and urban spaces (e.g. invasive alien trees which have been allowed to grow in nature areas particularly on the urban interface and around houses, creating fire bridges from natural spaces into urban areas), and in ecotones (e.g., there is usually a harder boundary between grasslands and forest, but when aliens invade both, fire can bridge from fire-prone grasslands into old forests which don't often burn).

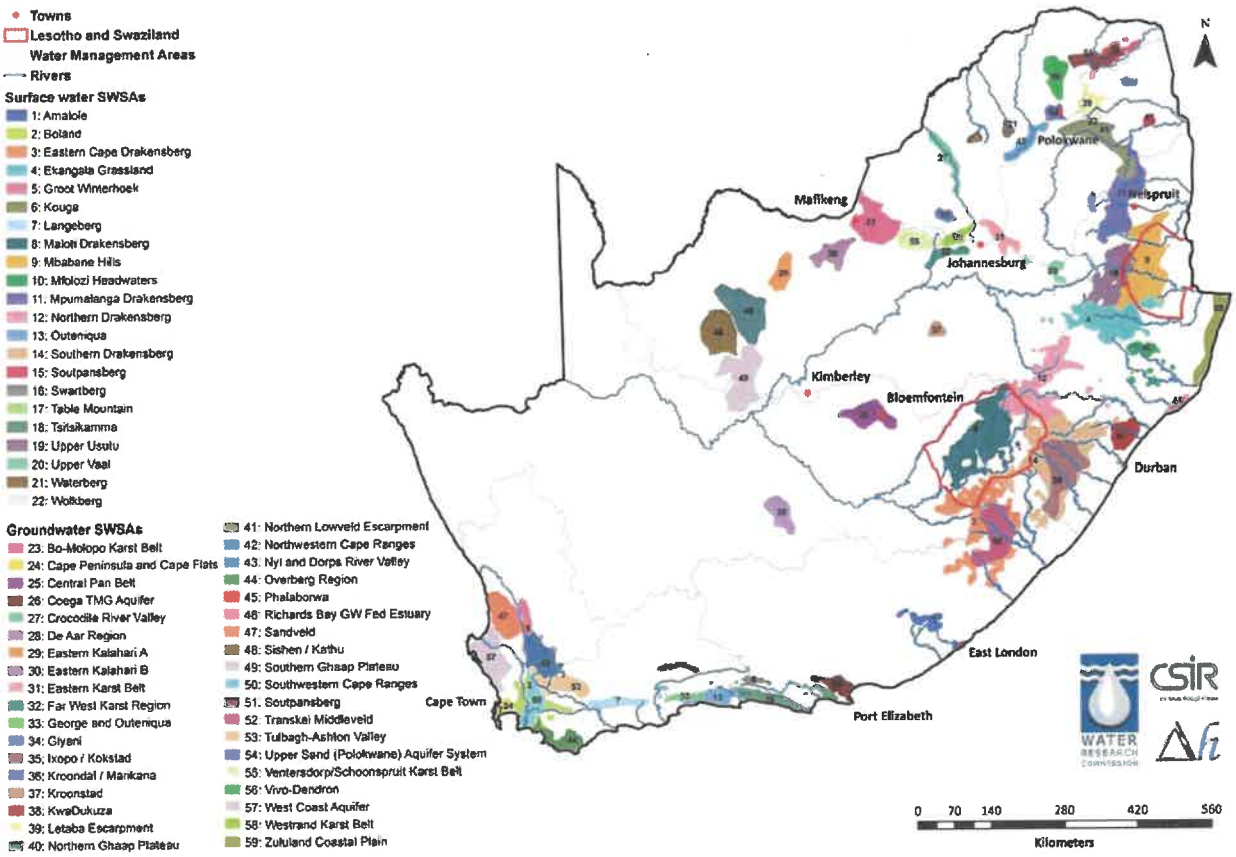
The devastating impacts of the 2017 Knysna fire, the 2021 Cape Town (University of Cape Town) fire and the Somerset West fire in 2022 on infrastructure, homes and livelihoods were made worse by alien plant invasions.

The increased fire intensity can scorch the soil, consuming the organic matter and making them water repellent and very prone to erosion. Some types of these alien trees also release chemicals into the soil to out-compete other native vegetation (called allelopathy), thereby changing the soil composition, leading to reduced soil organic carbon, soil denudation, and exacerbating erosion.

This soil loss, and the loss of soil organic carbon, as well as the loss of native vegetation that stores a large part of its biomass underground in bulbs, tubers, corms etc. (safe from fires) results in a net loss of carbon from these ecosystems. This may seem counter-intuitive because trees are often thought of as a means to trap carbon. However, in fire-prone and adapted ecosystems, where all above-ground biomass is burned regularly, trees do not equate to more carbon being trapped from the atmosphere, but rather the opposite.

Last but not least, alien trees negatively impact biodiversity, threatening critical plant and animal species, as well as entire vegetation types (e.g. critically endangered Peninsula Granite Fynbos is highly threatened by alien gums and wattles in the Cape).

We need to restore ecosystems for climate change adaptation, by clearing invasive alien trees. Recognising the urgency of these efforts, the United Nations has declared this current decade the ***Decade on Ecosystem Restoration*** (2021-2030). However, to be able to do alien tree clearing systematically and effectively, accurate and up-to-date maps are required to guide prioritisation and costing. This is where the MAPWAPS project aims to fill the gap.



The strategic water source areas of South Africa. The four proposed project study sites are in the Luvuvhu River, Sabie-Crocodile, Tukhela and Mzimvubu catchments.

Cape Biosphere Reserve

Felling of invasive alien pine trees in the fynbos, Western Cape

Bonani Madikizela, Research Manager at the Water Research Commission (WRC) observes that: "It is therefore worth noting that the WRC is investing in water security and ecosystem services through funding projects such as this one and others in order to generate a nature-based solution toolbox on how best to rehabilitate the extensively degraded ecological infrastructure in the country. Some of the projects are focusing on siltation management."

"These results would be useful input data for hydrological models, or to inform hydrological modelling for water resource management, thereby enhancing their accuracy."

What does the project involve?

The project has two key components: (1) to map invasive alien trees using freely available satellite imagery and field data in key strategic water sources areas (sites) in South Africa, and (2) to estimate their water use relative to native vegetation also using freely available satellite-derived products.

The first component will involve not only mapping alien tree occurrence and distribution, but also to estimate density and age for the target taxa. The free Google Earth Engine platform and robust machine learning algorithms will be harnessed to cloud-process Sentinel-2 imagery along with training data to produce the maps.

Using satellite imagery is what makes this work different from other projects that have gone before, which typically used modelling approaches, or relied solely on field data collection or systematic sampling alone.

The field campaigns will involve a few weeks of intensive field sampling at each site to collect training data (which will be collated on the citizen science platform iNaturalist.org), using photographic evidence.

Within each site, short workshops will be held with relevant stakeholders (scientists, managers, NGOs, volunteers, etc.). The resultant maps will be shared with these stakeholders during the process for sense checking and validation.

The second component of the project aims to estimate the water-use of the alien trees mapped relative to native vegetation. This will be undertaken by upscaling ground-measured water-use to freely available satellite-derived products (e.g. MOD16).

This will provide a better understanding of the impact of the alien tree invasions on water resources by deriving the incremental water use by the invasions over and above that used by the indigenous vegetation. These results would be useful input data for hydrological models, or to inform hydrological modelling for water resource management, thereby enhancing their accuracy.

Where will the project take place?

Four sites have been selected by the study team: the Luvuvhu River catchment in Limpopo, the Sabie and Crocodile River catchments in Mpumalanga, the Tukhela River catchment in KwaZulu-Natal and the uMzimvubu River catchment in the Eastern Cape.

These sites were selected based on four key criteria: (1) water security – they needed to be important strategic water source areas within their region, (2) alien trees – strategic water source areas that experience the greatest estimated reductions in runoff due to invading trees, (3) spatial variation – to capture a spread of biomes, climate etc., and (4) data scarcity – sites for which data are lacking and needed.

The final selected sites span four provinces, different biomes (forest, grassland and savanna), and a range of different climates (bimodal to summer-rainfall), soils, socio-economic context's and land-uses.

We will be working closely with local initiatives within these catchments where possible, for example the Environmental and Rural Solutions in the uMzimvubu catchment, Eastern Cape. If you would like to get involved by joining a stakeholder workshop in your region, please contact Dr Alanna Rebelo at RebeloA@arc.agric.za.

References

- Le Maitre, D. C. et al. (2016) 'Estimates of the impacts of invasive alien plants on water flows in South Africa', ***WaterSA***, **42**(4), pp. 659–672. doi: http://dx.doi.org/10.4314/wsa.v42i4.17.
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