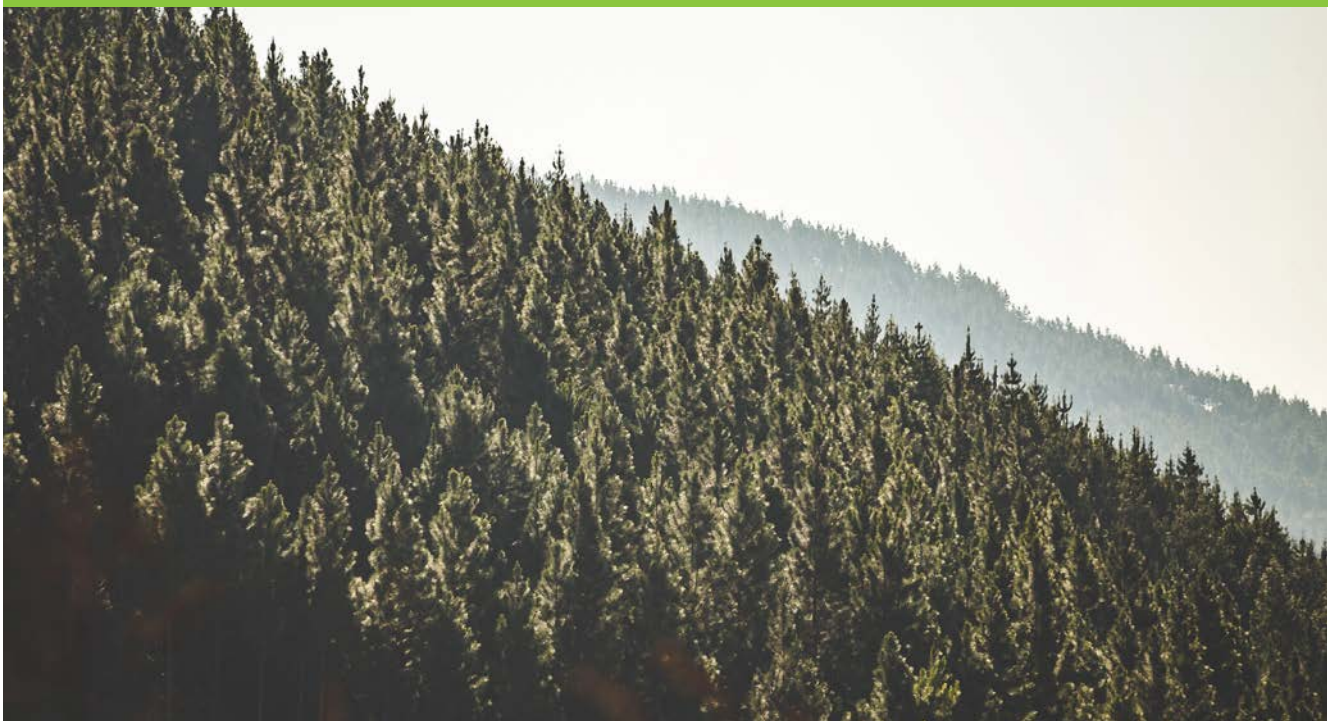
INVASIVE ALIEN PLANTS

Water vs wood: The high cost of alien trees in South Africa's catchments

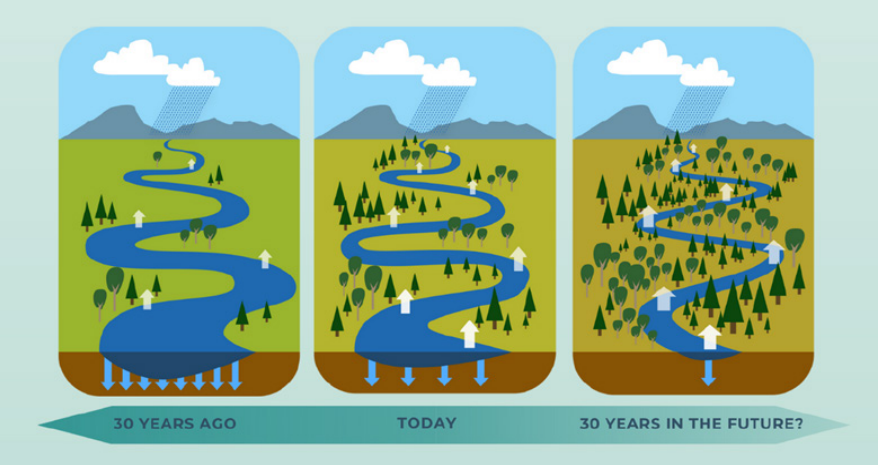
A three-year research project, funded by the Water Research Commission (WRC), has made a significant contribution to addressing the issue of invasive alien plants in South Africa. The project provides imperative recommendations for managing this threat to the country's water security. Article by Alanna Rebelo and Lani van Vuuren, based on a policy brief, written by Alanna Rebelo, Liam Cogill, Thandeka Skosana, Karen Esler, Errol Douwes, Jackie Jay, Sipho Magagula, Bonani Madikizela, Christo Marais, Nicky McLeod, John Phangisa and Tendai Sawunyama.



South Africa is one of the most water-stressed countries in the world. Rainfall is erratic, rivers often run dry, and climate change is intensifying the pressure. Yet, at the same time, millions of litres of precious water are being lost each year to invasive alien trees. These plants grow fast, spread rapidly, and use up far more water than native vegetation. They also fuel intense wildfires and crowd out biodiversity.

Running from 2022 to 2025, the Mapping Woody invasive Alien Plant Species (MapWAPS) project was a trailblazing initiative which piloted remote sensing approaches for mapping alien trees in different biomes, with the long-term vision of producing a national map. The project used freely available satellite imagery and machine learning to map invasive alien trees within catchments that intersect with strategic water source areas (areas which cover 8% of South Africa's surface but supply 50% of runoff). Water-related impacts were estimated using freely available remote sensing products and an ensemble evapotranspiration model built within the project, which was validated using 14 flux tower stations nationwide.

It is expected that these maps and tools will be critical for water resource managers, conservationists and policymakers to make informed decisions in protecting South Africa's water resources. By mapping the distribution, extent and impact of invasive alien trees, the team gained valuable insights which were taken into



South Africa has long known that invasive alien trees threaten our water resources. The Working for Water Programme began in 1996 to stop the spread and reduce water loss. Yet, nearly 30 years later, the problem is growing, underscoring the need for upscaling investment and maintenance. We now face a choice: allow further invasion and impact, or act to restore our ecosystems.

consultations with experts from different government departments, non-profit organisations, catchment management agencies, parks managements and catchment partnerships. From these consultations, nine key statements with recommendations were distilled.

1. Clearing invasive alien trees in strategic water source area catchments has major water benefits

Clearing woody invasive alien plants in all four of the study catchments could release over 100 mm a year if they are restored to a native treeless ecosystem, such as grasslands, shrublands or wetlands. Even restoring to a treed ecosystem, such as a forest (where appropriate), produces water gains compared to alien tree invasions of wattle, pine, gum and poplar (by about 20 mm a year).

		NATIVE ECOSYSTEM		
		GRASSLAND	FOREST	WETLAND
ALIENS	WATTLE	76	17	68
	GUM	134	24	118
	PINE	113	16	114
	POPLAR	-	8	27
	BUGWEED	141	-	-
	LANTANA	111	-	-

Amount of water release in mm/year when restoring native ecosystems by clearing alien tree invasions (note: mm represents depth over an area, for example, 1 mm = 10 m^3/ha/year.)

If we cleared all the gum, pine and wattle invasions (not including plantations) in each of the four study catchments and restored these areas to native ecosystems, we would be able to free up approximately 110 million m^3 of water overall. This equates to water for over 770 000 households each year (based on 100 L per person, and four people per household).

2. Sustainable investment is key

This research has shown that alien trees have invaded between 1% and 5% of catchments within strategic water source areas. A publication by Kotzé et al (2025, https://rdcu.be/eEh2e) reported that the investment in alien tree clearing over the last 25 years in South Africa has not resulted in the desired reduction of invasion. Although the programme slowed the spread of alien trees, why was it not more successful?

Part of the reason, according to the experts engaged, is that investment has been insufficient (despite being substantial) as well as intermittent. This has made running alien tree-clearing programmes challenging. Permanence and security of jobs have been a major shortcoming and have had socio-economic consequences.

Sustainable investment into invasive alien tree clearing is critical. There needs to be a long-term, strategic vision with buy-in and

collaboration of all stakeholders. We recommend planning on a 50-year timeframe.

3. Clearing invasive alien trees within a restoration framework leads to water-related co-benefits
Clearing invasive alien trees followed by restoration to a native ecosystem not only makes more water available (water provision or yield) but also assists with water regulation. Infiltration is higher under native ecosystems such as grasslands or fynbos than under invasive alien trees or plantations.

This infiltration allows soil water stores to replenish and, in some cases, also allows aquifers to recharge. Slowing the movement of water through the landscape means that this additional water doesn't rush from the surface all at once, preventing flooding downstream as well as reducing drought risk. Therefore, invasive alien tree clearing within a restoration framework is a very important strategy for South Africa to consider in terms of climate change adaptation.

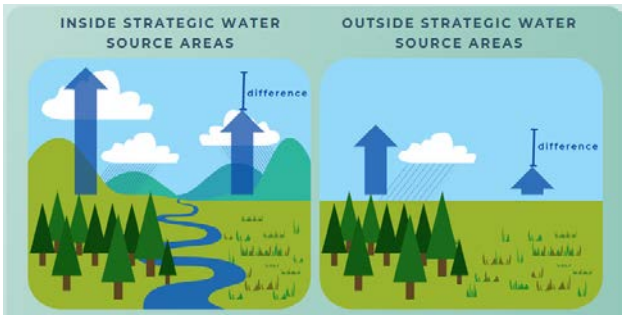
Clearing invasive alien trees with restoration helps to build resilience back into our ecosystems. Resilience means the ability of an ecosystem to recover after a shock, such as a flood, fire or drought. All these benefits imply that invasive alien tree clearing and restoration can contribute to securing the strategic water source areas in South Africa.

4. The relative water impact of invasive alien trees is consistent inside and outside strategic water source areas
The research has shown that inside strategic water source areas, invasive alien trees use more water, but so does the native vegetation. This means that, relatively speaking, the water impact of alien tree invasion, or clearing, is the same inside compared to outside strategic water source areas.

It is important to note that we didn't consider groundwater strategic water source areas, only surface water ones. It is possible that where invasive alien trees have access to a source of water that is not available to native vegetation (e.g. trees tapping groundwater that grasses with shorter roots cannot access), such as groundwater, invasive alien trees will use proportionally more water relative to native vegetation. More research on invasive alien tree impact on water resources in groundwater strategic water source areas should be an urgent priority, as it may advise priority areas for invasive alien tree clearing, where investment can have a larger impact on water availability.

5. Forestry in strategic water source areas trades economic gains for significant water costs
Having plantations within strategic water source area catchments presents a trade-off: these plantations have economic benefits, but they also have a major water cost relative to native ecosystems that they replace (even indigenous forests). In certain strategic water source areas, rezoning of land-use activities could be beneficial to protect water sources.

Considering actions such as the restriction of any further water use licences for plantation forestry in water-stressed catchments, as well as strategic water source areas, could be beneficial in terms of water resource management. Forestry companies wishing to reduce their water footprint could also consider genus swapping to taxa that consume less water within their specific bioclimate.



Invasive alien trees inside strategic water source areas use more water compared to those outside them; however, so does the native vegetation. Therefore, the relative amount of water freed up when clearing invasive alien trees and restoring to native ecosystems is the same, whether inside or outside of a strategic water source area.

6. Many alien invasions are a legacy of forestry
This study demonstrates that alien tree invasions are most severe in areas surrounding plantations and decline with increasing distance from them. Given that plantation forestry is a major driver of these invasions, the forestry sector should bear responsibility for managing and controlling their spread. This issue must be addressed by all entities within the sector, including both private companies and state-owned enterprises.

It is ethically indefensible for the citizens of South Africa to bear the financial burden of clearing invasive alien trees or suffer the resulting loss of ecosystem services, while forestry operations continue to profit without internalising the environmental costs they impose. Forestry companies must incorporate the costs of alien tree invasions into their pricing structures. If the true cost of forestry – including the ecological and economic impacts of invasions – were accurately accounted for, the sector's profitability might be significantly reduced.

Holding the forestry sector accountable for restoring the ecological degradation it has caused could incentivise more responsible practices. This includes increased private-sector investment in solutions such as the development of sterile cultivars and the advancement of biological control measures.

We recommend that the legislation around accountability for the spread of invasive alien trees be urgently strengthened. Companies and landowners should be legally required to clear alien trees that have spread from their plantations, regardless of how far they have dispersed, and to actively restore the affected ecosystems. In the longer term, we recommend that the government consider bans on the planting of tree species known to be major invaders. These are species that have cost the country billions of Rands in damages and hundreds of millions annually over the past 25 years in clearing efforts.

Such measures could be implemented through stronger wording and penalties in the National Environmental Management: Biodiversity Act (Act No. 10 of 2004), and subsequent revisions, as well as improved enforcement.

The approaches we have developed could also assist the government with monitoring and compliance.

7. The water-related impacts of plantation forestry non-compliance

The study found widespread alien tree invasions within riparian zones (areas alongside rivers) across all four study catchments. These invasions are of particular concern, as invasive alien trees in riparian areas are known to have disproportionate impacts on water availability. Notably, we also observed that many plantations are located within these sensitive zones, in direct violation of environmental regulations. According to legislation guidelines, forestry operations are required to maintain a 20-metre buffer from the edges of rivers and wetlands.

Despite this obligation, our findings reveal frequent non-compliance, with numerous plantations extending directly into riparian zones and wetlands. If these areas were restored and companies brought into compliance, substantial volumes of water could be recovered. For example, in the Sabie-Crocodile catchments, 18.7 million cubic metres of water would be made available each year if plantations and alien tree invasions were removed from the riparian buffer zones.

We recommend that plantations should stay out of riparian zones and floodplains (e.g. above 10-20 year flood lines). To facilitate this, the government should strengthen inspection and enforcement mechanisms and enhance oversight of the Forest Stewardship Council certification process in South Africa.

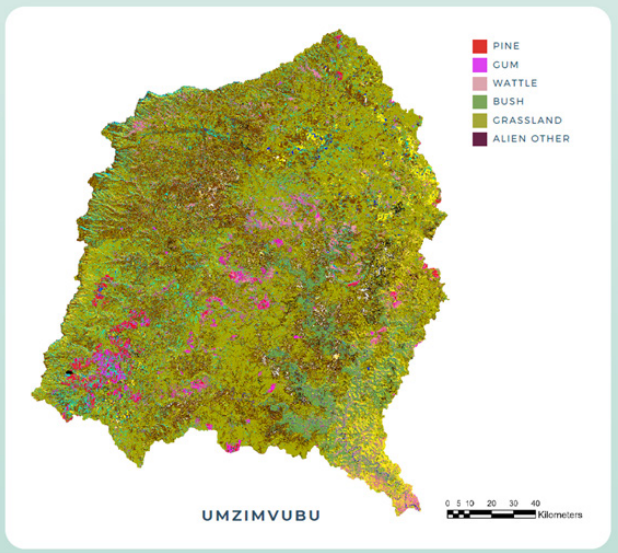
8. Up-to-date invasive alien tree maps are needed

Effective management of invasive alien trees requires accurate knowledge of their locations. Given the rapid rate at which these invasions spread, regularly updated maps are essential for timely and effective intervention. This highlights the need for a mapping approach that is both easily updatable and therefore readily repeatable. The MAPWAPS approach has been developed for this purpose and has achieved good accuracy results.

Investment in such a mapping process, and the resulting outputs, is critical not only for on-the-ground management, but also for fulfilling national and international reporting obligations, such as the National Biodiversity Assessment and commitments under the Global Biodiversity Framework. The method developed in this project offers a practical solution by providing a repeatable approach for generating regularly updated, national-scale maps of invasive alien trees. We strongly recommend that ecological expertise be a core requirement in the development and interpretation of these maps to ensure their accuracy and relevance.

9. A water-use calculator is needed to calculate the benefits of clearing invasive alien trees

We recommend investment into the development of a tool to enhance estimates of the water-use impacts of invasive alien tree clearing, using satellite remote sensing products as demonstrated in this study (Cogill et al. 2025, https://www.sciencedirect.com/science/article/pii/S235293852500165X). Such a tool could play a vital role in supporting evidence-based decision-making and ongoing monitoring in water resource management.



An invasive alien tree map of the uMzimvubu River catchment scored an overall invasive alien tree accuracy of 97%, and 94% for telling alien tree taxa apart.

Currently, the most widely used tool focuses solely on streamflow changes, based on the streamflow reduction curve concept. In contrast, the MaPWAPS approach captures comprehensive changes in water availability, including both surface and groundwater**.** This represents a significant advancement over existing methods and makes strategic use of freely available satellite imagery to improve water management.

Furthermore, this approach aligns with the government's priorities for digital transformation within the environmental and water sectors. A water-use calculator is needed to calculate the benefits of clearing invasive alien trees.

Conclusion

South Africa has been spending around R300 million a year on alien plant clearing programmes, yet invasions continue to spread. The MapWAPS project shows that better data can support smarter planning to make this investment go further. A more strategic approach to alien tree clearing could save billions of litres of water each year, protect biodiversity and build resilience against climate change. The United Nations has declared this the Decade of Ecological Restoration. We are already halfway through the decade, and the bulk of the work is yet to be done.

To access the final report, ***Mapping woody invasive alien plant species and their impacts in strategic water source areas*** (**WRC report no. 3193/1/24**), visit: https://www.wrc.org.za/wp-content/uploads/mdocs/3193%20final.pdf

To access the policy brief, ***Alien tree invasion in South Africa: Status and impacts on water in strategic water source areas***, visit: https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/Policy%20Brief_MAPWAPS.pdf