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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.

POLICY BRIEF

Exploring the groundwater use of invasive alien plants

A recently completed Water Research Commission (WRC) study investigated the water use by Prosopis spp (an invasive alien plant) compared to co-occurring Vachellia karroo trees before and after clearing the invasions. While individual trees of invasive alien plants were shown not to use much more water than indigenous deep-rooted trees, when forming dense stands Prosopis was found to have a considerable impact on groundwater levels.

Background

Invasive alien plants are estimated to have invaded at least 10 million ha of South Africa to some degree, and are spreading at 5% per annum.

Prosopis is a dominant groundwater dependent alien invasive species found in the arid and semi-arid parts of South Africa. A deep-rooted shrub, the plant originates from Central America, and was first introduced to Namibia and the north-western parts of South Africa mainly for fodder, fuel and shade in the late 1800s.

This species is well-known for its ability to thrive under semi-desert conditions by accessing groundwater using its deep tap root. Tap roots have been found at depths exceeding 50 m.

Various ***Prosopsis*** species have become invaders and have spread to other parts of the country. They have invaded the Nama Karoo and arid savannah in parts of the Western Cape, Eastern Cape, North West and Limpopo, and are spreading into adjacent grasslands.

The rapid spread of this invasive alien plant, particularly along river courses and floodplains where it forms impenetrable thickets, has raised concerns about its impact on groundwater resources, especially for groundwater-dependent farmers and rural communities. It was these concerns that led to a three-year WRC project aimed at determining the impacts of ***Prosopsis*** invasions on groundwater.

The main purpose of the study was to quantify the long-term patterns of groundwater use by ***Prosopis*** invasions and compare them with co-occurring indigenous trees. This information on the impacts can then be used to prioritise areas for clearing ***Prosopsis*** and protecting groundwater.

Main results

The study was conducted at a site that is densely invaded by ***Prosopis*** at ***Brandkop*** farm near the groundwater-dependent town of Nieuwoudtville, Northern Cape. The site also had significant amounts of indigenous deep-rooted ***Vachellia karroo*** trees.

Prosopis invaded floodplain of the Doorn River at Brandkop farm in the Northern Cape.

To understand the water use of both tree species, researchers monitored the volumes of water taken up by both ***V. karroo*** and ***Prosopis*** in relation to the weather, soil water content and groundwater levels. They are also

measured the water uptake by the roots of both species using water flow sensors installed on the tap and lateral roots of selected trees.

The sources of water transpired by the trees (whether soil water or groundwater) were determined by matching the stable isotope signatures of water from twigs with different water sources.

The first one-and-a-half years of the project involved monitoring the site with both species present. ***Prosopsis*** invasions were then cleared and detailed monitoring continued of the remaining indigenous vegetation for the remaining research period.

This intensive monitoring is the first of its kind in South Africa to involve detailed assessments of the interactions of both invasive alien and indigenous trees with groundwater in the drier parts of the country.

Main results

The amount of water transpired by individual ***Prosopsis*** trees was found to either be equal to, or in some cases even lower than, that of an ***V. karroo*** of the same size. This was because the water transport pathway (sapwood area) of the invasive alien plant stems is substantially narrower than that of the indigenous plant.

However, if water use by the whole population of each species is considered, ***Prosopis*** transpires at least four times more water than ***V.karroo***.

This is because the alien invasive plants were very dense compared with the indigenous vegetation. So the ability of the ***Prosopis*** to form dense thickets with large numbers of plants per unit area, rather than high transpiration by individual trees, is the main reason why their water use exceeds that of indigenous vegetation.

The researchers have further observed an interesting phenomenon during the root water uptake studies. They found that ***Prosopis*** is manipulating the available water in this exceedingly dry region to its advantage while the indigenous ***V. karroo*** is not.

Groundwater taken up by the ***Prosopis*** tap root is not all immediately transpired. Much of the root water leaks out into the upper soil profile, presumably for use later when there is less water available.

The result is a greater average soil water content under ***Prosopis*** than under ***V. karroo***. Scientists call this phenomenon of water movement 'hydraulic redistribution', or more accurately 'hydraulic lift'.

While the indigenous ***V. karroo*** also uses groundwater, no water redistribution occurs, and all the water absorbed by the tap roots is immediately transpired, leaving the trees with no buffer against periods of water shortage.

The ability of the invasive alien plants to 'move' water for later use significantly enhance the chances of survival of young ***Prosopis*** seedlings, probably contributing to the rapid increase in the populations of this species compared to co-occurring indigenous trees. Stable isotope data shows that ***Prosopsis*** obtains about 77% of its water from groundwater compared with 47% for ***V. karroo*** during the peak summer period.

The study found that ***Prosopis*** consumed at least 4 200 m^3 of groundwater per hectare per year compared to only 420 m^3 per hectare per year for ***V. karroo***.

Conclusions and recommendations

This study demonstrated that deep-rooted indigenous trees growing in arid to semi-arid environments are equally likely to use as much or more water per plant than invasive alien plants. However, the pronounced impacts of ***Prosopis*** invasions on groundwater are a result of the ability of the species to form dense stands as opposed to higher water use rates by individual trees ***per se***.

Prosopis had adaptation strategies to survive harsh conditions, for example, manipulating available water resources when groundwater levels are high. The indigenous ***V. karroo*** does not have these attributes.
Clearing ***Prosopis*** is an effective strategy to increase the volume of groundwater which is critical in groundwater-dependent communities. Priority should be stands with a high density of ***Prosopis*** and few or no deep-rooted indigenous trees.

Further reading:
To order the reports, ***Comparison of water use by Prosopis spp and the co-occurring Vachelia Karroo trees before and after clearing the invasions: Implications on groundwater*** (**Report No. 2256/1/16**), contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.