Tree water use and sensitivity to contaminated mine water

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Northern Australia Environmental Resources Hub

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This project is assessing the sensitivity of riparian (riverbank) tree species to magnesium sulfate ($MgSO_4$) along Magela Creek, which runs through the Ranger uranium mine lease and Kakadu National Park, and determining the sources of water for riparian trees (soil water, groundwater or a mix of both). This information will be used to assess the risks posed to riparian trees from elevated concentrations of $MgSO_4$, derived from the weathering of waste rock at Ranger uranium mine, entering the local groundwater system.

What's new?

- Our paper on the first phase of glasshouse experiments to assess the effects of elevated $MgSO_4$ on *Melaleuca viridiflora* (broad-leafed paperbark) and *Alphitonia excelsa* (red ash) has been published in the Nature journal *Scientific Reports*.[1] We found that the growth of *A. excelsa* was not affected until $MgSO_4$ concentrations in soil water exceeded 960 mg/L. There were no measurable effects of elevated $MgSO_4$ on *M. viridiflora* at the concentrations we tested.
- The second phase of glasshouse experiments testing another four common tree species has been underway for 10 months. We have observed little to no effect on the growth of these species after seven months of exposure to elevated $MgSO_4$. Plants will be harvested in April to quantify biomass and assess ion concentration in plant tissues across all treatments.
- In October 2019 we undertook our second major sampling at Magela Creek to assess the dependence on groundwater in six common riparian tree species at our three field sites. We collected twigs from each species, soil from different depths up to 3.2 m, and shallow groundwater. Groundwater samples and water extracted from the twigs and soil will be analysed for the stable isotopes deuterium and ^{18}O which can tell us the source of the water. The West Australian Biogeochemistry Centre has analysed around 230 samples collected over three field trips.
- Samples of deeper groundwater are being analysed for stable isotopes and for tritium, a radioactive isotope of hydrogen, which allows us to estimate the 'age' of the groundwater. Tritium analysis is being undertaken by the Australian Nuclear Science and Technology Organisation (ANSTO).
- Staff of the Australian Government's Supervising Scientist Branch (SSB) at Jabiru are collecting daily rainwater samples throughout the 2019–20 wet season for isotope analysis.

What's next?

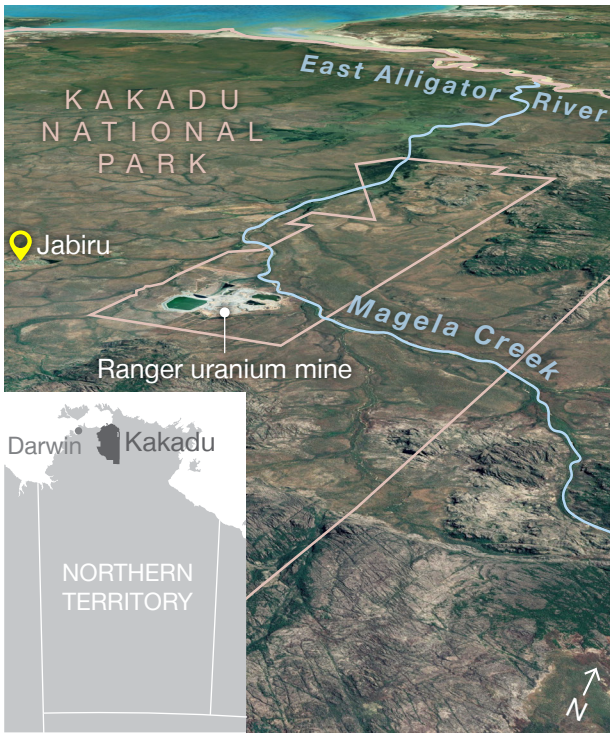
- We'll use mathematical models to determine what proportion of water from each source – soil water at different depths, shallow groundwater, deeper groundwater – is being taken up by each tree species. We'll use the tritium data to model the rate of groundwater flow towards Magela Creek and compare this with groundwater flow models developed by Ranger uranium mine operator Energy Resources Australia Ltd (ERA).
- The third phase of the glasshouse experiments will examine two species that are culturally important to Indigenous people of the Kakadu region – *Barringtonia acutangula* (freshwater mangrove) and *Pandanus aquaticus* (river pandanus). Both species occur on creek banks.
- Given *A. excelsa* showed impacts at 960 mg/L $MgSO_4$, we will conduct further trials on this species, but at levels close to this concentration to determine a more accurate threshold.

Associate Professor Samantha Setterfield (UWA) and Adam Bourke (CDU) in the greenhouse at CDU, photo Lindsay Hutley.

- We will also select sites on Magela Creek that have a history of elevated $MgSO_4$ levels and assess tree health of vegetation in the field. This will be done in collaboration with SSB staff.
- We will continue to share the data and knowledge gained from our research with SSB, ERA and other stakeholders, such as Kakadu Native Plants Pty Ltd who collected seed for the glasshouse experiments.

Project summary

The Ranger uranium mine is due to cease operations in 2021, with rehabilitation works planned to be completed by 2026. Weathering of waste rock from the mine releases contaminants, including $MgSO_4$. These contaminants are washed out by rain and are predicted to move through local groundwater to Magela Creek. High concentrations of $MgSO_4$ have the potential to affect the health of trees and other plants growing along the banks of Magela Creek. This study is generating greater understanding of where common riparian trees source their water, especially during the dry season, and how coming into contact with elevated concentrations of $MgSO_4$ affects tree health. The information gained from this study can also be used to identify the most appropriate species for rehabilitation of sites with high concentrations of $MgSO_4$ should detrimental impacts on tree health be observed after mine closure.



Magela Creek runs through the mine lease and Kakadu National Park.

REFERENCE

1. Canham CA, Cavalieri OY, Setterfield SA, Freestone FL & Hutley LB. 2020. Effect of elevated magnesium sulfate on two riparian tree species potentially impacted by mine site contamination. *Scientific Reports* 10, 2880. https://doi.org/10.1038/s41598-020-59390-9

Further information

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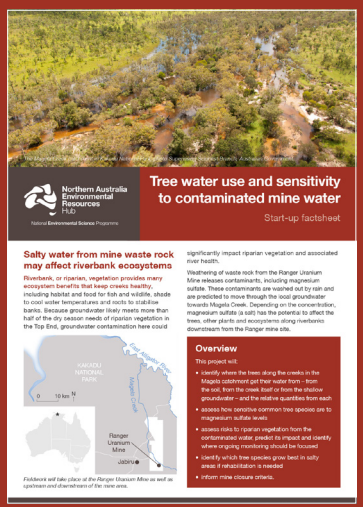
The project page can be found on the Hub website, along with the project start-up factsheet.

This project is due for completion in December 2020.



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