**Exploring How Trees in Savannas Respond to Drought**

Savannas are characterised by the co-existence of two very different types of plants – trees and grasses. They may be open, with large swathes of grass and an occasional tree dotting the landscape, or closed with a near complete cover of trees and a sparse grass layer beneath. In drier parts of the world, drought may play an important role in determining the balance between the trees and grasses in savannas. Extreme droughts, which are likely to become more common with climate change, could permanently shift a closed savanna to an open one. Such changes would have significant consequences for the functioning of these ecosystems and the animals they support. Dr Anthony Swemmer of the South African Environmental Observation Network explored the impact of an unusually severe drought on trees in South Africa. His team’s research shows that the response of trees to drought depends on a suite of local factors.

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Global climate change is causing droughts to become more frequent and severe in numerous regions around the world. Models forecast that Southern Africa will be hit particularly hard in the decades to come. These forecasts have biologists wondering how African savannas, grassy plains that cover almost half of the continent’s surface, will fare.

We’ve all seen savannas in nature documentaries. We can imagine the lioness prowling underneath the tall grasses that perfectly match her coat, allowing her to blend in surreptitiously. After a long day of hunting, we see the lioness lounging beneath a single tree, enjoying the shade.

Trees provide critical ecosystem functions in savannas, although they can have negative impacts if they become too abundant. They create microenvironments by depositing leaf litter that can support diverse plants and fungi, but can shade out certain plant species. They provide shade for many animals and food for giraffes, elephants and other browsing herbivores, but also compete with grasses and can reduce the forage available for grazing animals.

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In forests, which are **better** studied than savannas, drought-related death of trees has adverse effects on carbon sequestration. Although scientists acknowledge that periods of drought in savannas may have the same negative consequences, they may also help savannas deal with other novel stressors. For example, increased human presence and development have expanded the abundance of certain tree species in savannas, changing the composition of natural vegetation. During times of high rainfall and abundant grass growth, regular fires play an important role in limiting the abundance of trees. More frequent droughts may serve as an additional check on these encroaching species.

Dr Anthony Swemmer of the South African Environmental Observation Network (SAEON [say-on]) understood that increased drought impacts would only provide benefits if the trees that encroach upon savannas suffered more mortality than other plant species. Also, increased mortality of encroaching species would need to occur on a large-scale if drought were to be beneficial to a savanna ecosystem.

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In a 2020 paper published in the *African Journal of Range and Forage Science*, Dr Swemmer reported results from research plots set up during and following a severe drought in north-eastern South Africa, which lasted from 2014 until 2016. His study is the first to investigate whether mortality was greater for encroaching species than for others.

Dr Swemmer and SAEON assistants recorded mortality rates of hundreds of individual trees, every year both before and during the drought. This was done at ten sites in the Lowveld Region of South Africa, with more sites added in the southern part of the famous Kruger National Park, where the impact of the drought appeared to be more severe.

Along with measuring growth rates and counting numbers of dead trees, Dr Swemmer and his team collected data on rainfall, soil type, and damage from elephants, as elephants can also cause tree death in savannas. They also measured grass cover to estimate the level of grass competition in each plot.

Across all sites, he found that mortality varied from 3 to 49%. This dramatic variation could be explained by drought severity, as measured by rainfall amounts. The less rainfall fell on a site, the higher the level of mortality.

However, Dr Swemmer also observed that tree mortality was highly variable within each site. Even at sites with high mortality, trees survived in some patches, but in other patches nearby, mortality was as high as 95%. To understand why, Dr Swemmer focused on the five sites with the highest mortality, and compared mortality between individuals.

He found that tree height was an important factor, as taller trees were far more likely to have died. For example, species greater than 2.8 metres tall experienced 71% mortality, yet all individuals shorter than 0.9 metres survived. This makes sense, as taller trees have to move water a further distance, against the force of gravity, to get it from the soil to their leaves. When soils become too dry, this eventually becomes physically impossible.

The location of a tree in the landscape also played a role, with greater mortality for trees growing on the crests of hills, compared to those growing on the lower slopes and valley floors. This was probably due to less water storage in the shallow and sandy soils that are typically found on crests.

An additional factor that was found to have some effect was the type of grass growing amongst the trees. Dr Swemmer noticed that trees growing in thick layer of grass were more likely to have died. This suggests that grasses were competing with trees for water during the peak of the drought, contributing to a critical shortage of water available for many trees.

Overall, however, it was the type of tree species that was the most important variable controlling whether trees died or not. Many species had low mortality regardless of exactly where they were growing, and *vice versa*. Interestingly, encroaching species did not show a consistent pattern – some of these species were *less* vulnerable to drought, and others suffered high mortality. These results suggest that future periods of drought will not necessarily provide a check on encroaching species, and may only prevent them from further dominating the landscape under certain circumstances.

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Overall, the study showed that the impacts of a long-term drought on trees varied substantially. In some plots, almost half of all trees had died, while in nearby plots, there was almost no drought-induced mortality at all.

Though differences in rainfall predicted much of the variation in mortality among different sites in different regions, it could not explain the dramatic variation within sites, where all trees experienced the same rainfall.

Dr Swemmer identified several important factors that may contribute to variations in mortality rate within the same site, including the species and height of an individual, its position in the landscape and the type of grass growing around it. However, when comparing the results of his study to others, only tree height emerges as a universal factor. Across the board, taller trees are more sensitive to the impacts of drought in both savannas and forests.

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South Africa will experience more intense droughts in the future, which may make the 2014 to 2016 drought seem minor by comparison. The results of this study give us a hint as to what savannas may look like as climate change progresses. Not only can we expect to see shorter trees in general, but also neighbouring landscapes may become more heterogeneous as trees respond to novel pressures in the local environment.

Overall, Dr Swemmer’s results suggest that drought-induced mortality patterns in savannas are complex, and we need future research to identify how different environmental drivers interact to affect the mortality of important trees.

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This SciPod is a summary of the paper ‘Locally high, but regionally low: the impact of the 2014-2016 drought on the trees of semi-arid savannas, South Africa’ from *African Journal of Range & Forage Science.* doi.org/10.2989/10220119.2020.1723696

For further information, you can connect Dr Anthony Swemmer at am.swemmer@saeon.nrf.ac.za