Human-induced water stress in riparian trees of the central Namib Desert

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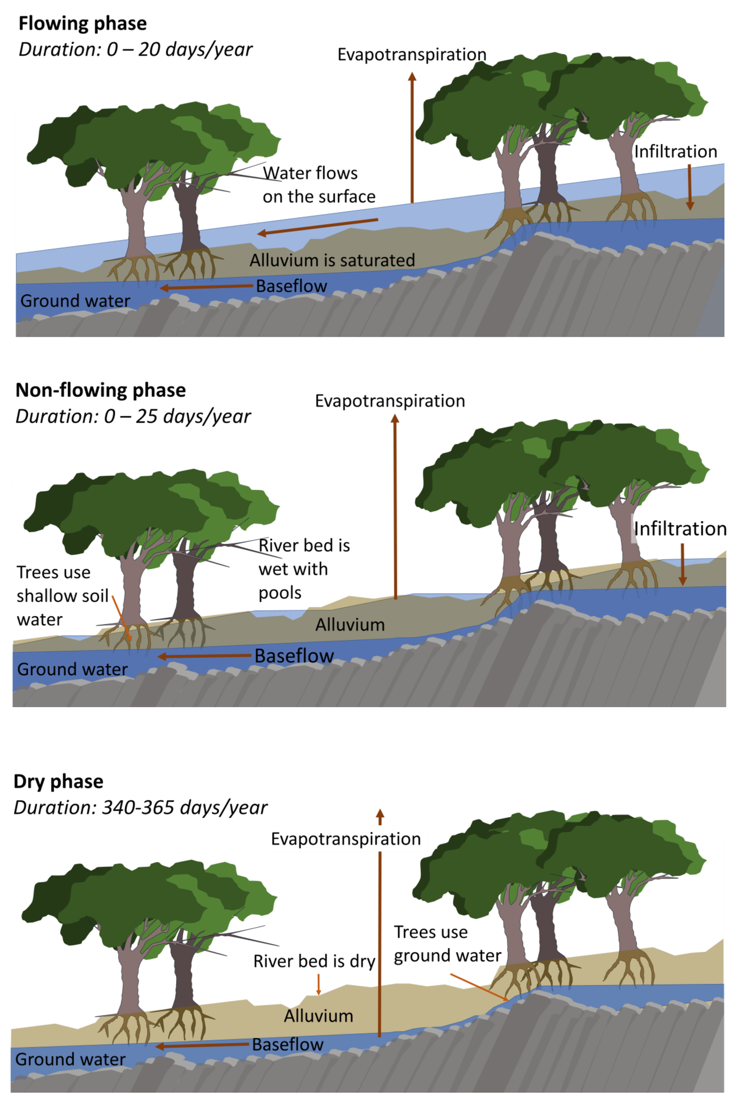
"Ephemeral" means "short-lived". This refers to the short period of time when water flows on the surface in an ephemeral river. The vegetation in an ephemeral river has adapted to short flow phases, non-flowing phases and prolonged dry phases.



All of Namibia's interior rivers are ephemeral. Most of these rivers run through the Namib Desert and support abundant vegetation. This vegetation, which include trees, is the lifeline for desert organisms and local human communities. The woodlands are sustained by groundwater in the river aquifer which trees access through their root system. If we protect this woodland, we protect human interests too.

Groundwater from river aquifers is also used for human consumption and industries. This water is abstracted through boreholes for farming, mining, manufacturing and other human needs.

Ephemeral rivers only flow for a few days in a year, if at all, but they store water belowground. People and riparian vegetation use this water.

The study focuses on three key species that are abundant in ephemeral rivers in Namibia:

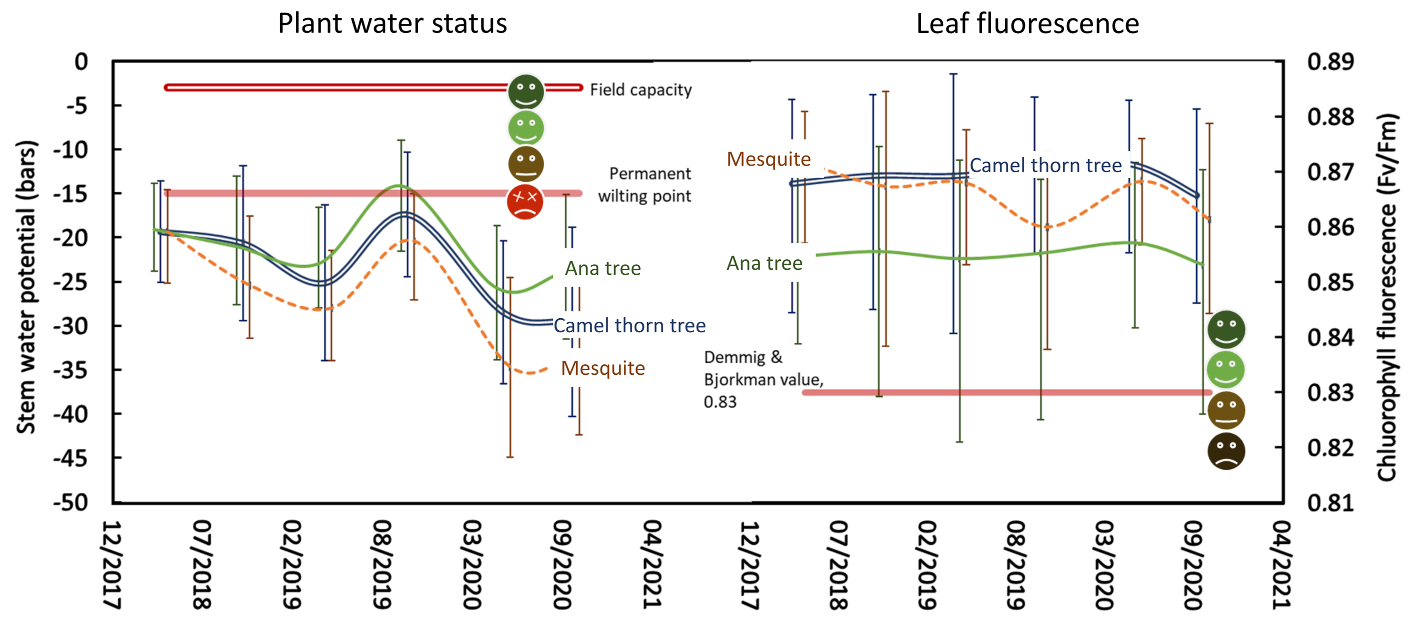
Ana (Faidherbia albida)

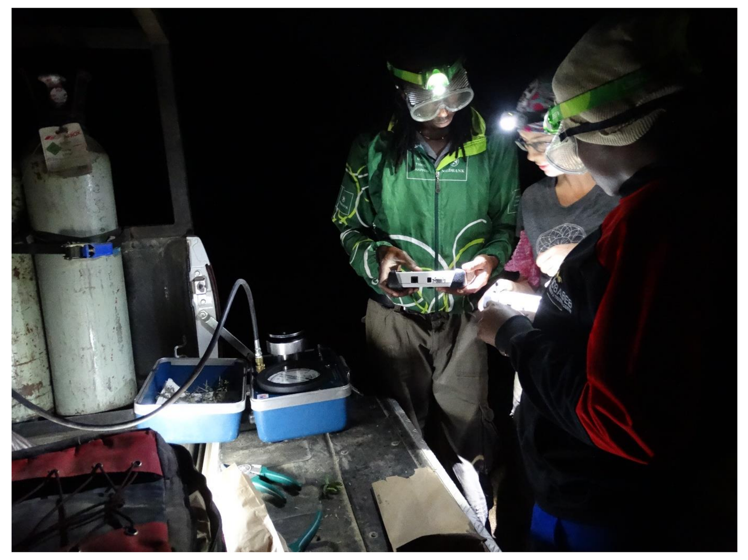
Camel thorn (Vachellia erioloba)

Mesquite (Prosopis glandulosa) – the invasive species.

How do you to tell if a tree is suffering from drought before it dies?

If a plant does not have enough water, it cannot use sunlight efficiently to make sugars. Without sugars, plant growth will stop and eventually the plant will die. NERMU measured the water status (stem water potential) and far-red light (fluorescence) emitted by leaves of 315 trees that grow around boreholes twice a year for three years. We did this to see how these measurements vary across seasons and what reference values to use when monitoring tree health. The information that we obtain from the far-red light can tell us if the plant can use sunlight efficiently. Notice the surprising result: even though the plants had a predawn water status below the permanent wilting point (according to text books), their photosynthetic health measured above the mean value for plants that were measured by scientists in the late 1980's that is the recommended benchmark for plant photosynthetic health (Demmig and Bjorkman 1987). Thus, we need to establish new benchmarks for these woodland trees.





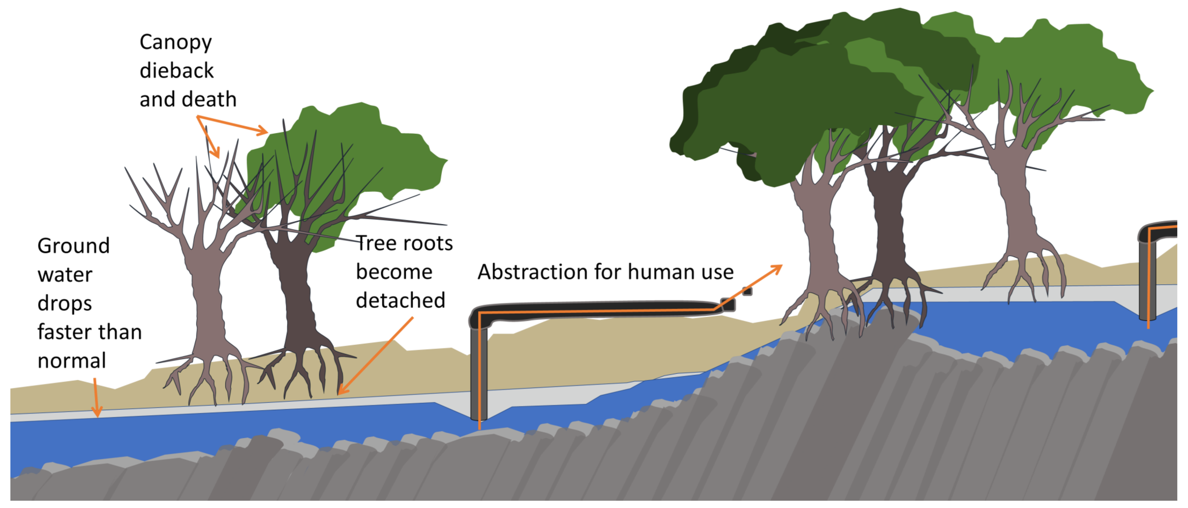
A camel thorn tree next to a production borehole in the Kuiseb River. The water abstracted from this borehole is used to supply the towns of Walvis Bay, as well as other industries in the Erongo Region.

If groundwater abstraction decreases the total water available to trees, will some trees die?

We evaluated the effect of abstraction on tree death in the Swakop, Kuiseb and Khan rivers. Groundwater that declined quickly correlated with increased mesquite and ana tree mortality.

We conclude that abstracting too much water will lead to tree death.

Effect of abstraction



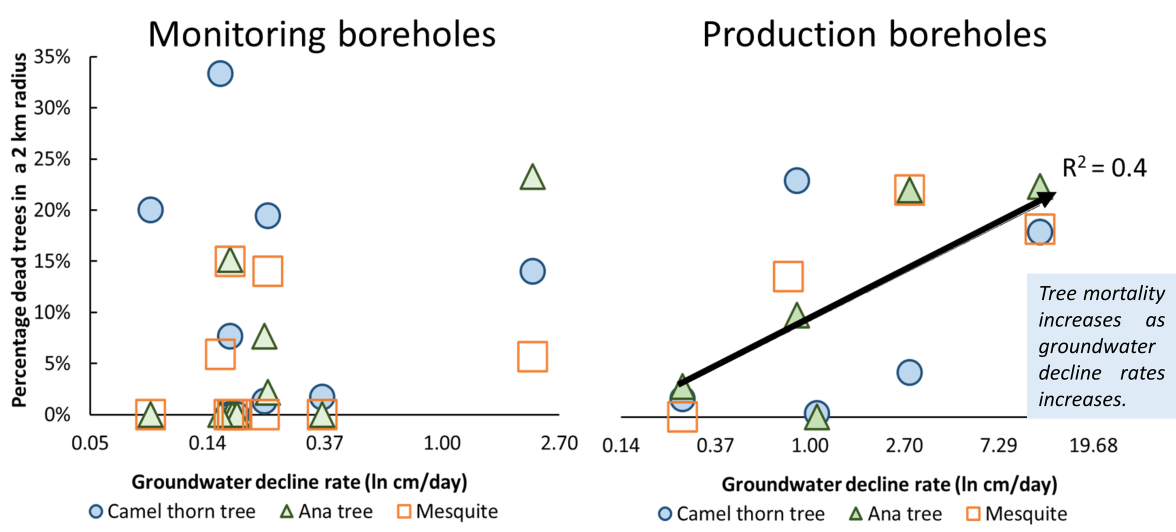
The ana tree below died, probably because reduced flooding in the Swakop River and evaporation caused groundwater decline. Abstraction can exacerbate this problem.

Can we meet the water demands of people and protect riparian woodlands?

First we have to find a way to monitor tree health so that we can identify unhealthy trees and reduce abstraction before trees start to die. We selected some indicators of tree health (canopy dieback, leaf size, stem water potential and leaf fluorescence) and evaluated their efficacy. We will discuss leaf fluorescence here only.

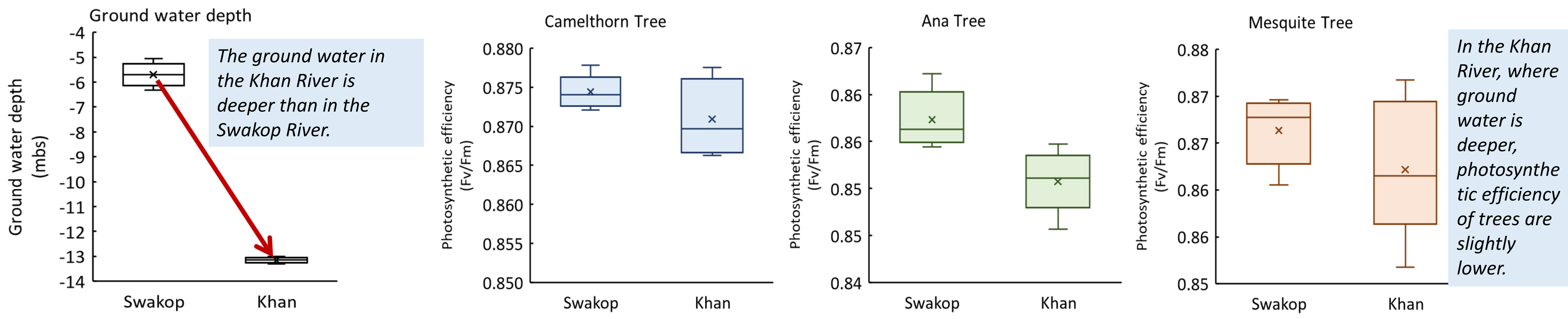
At monitoring (no abstraction) boreholes there is no correlation between tree mortality and groundwater decline rate.

At production (abstraction) boreholes there is a correlation between tree mortality and groundwater decline rate.



Are the fluorescence measurements related to groundwater level?

Using the fluorescence data that we collected, we found a correlation between groundwater depth and tree health. Trees are healthier where the ground water is shallow. In other, related studies we have also determined that the rate at which the water level drops has a marked influence on tree health. Therefore, if groundwater abstraction causes groundwater to drop too low too quickly, the effect on the trees' health should be detectable in the fluorescence measurements.



We conclude..

Our results suggest that groundwater level measurably affects tree health in terms of photosynthetic efficiency to the point that deaths may occur as a result of abstraction. However, on average all three species that we studied are remarkably resilient over time, maintaining physiological activity at levels of water availability that is normally considered to be below the wilting point.

Our study contributes to the knowledge on the physiological responses of different tree species that are also common in ephemeral rivers in Namibia. Our results will assist in the development of monitoring protocols to detect water stress in trees, with the ultimate aim of improving our ability to identify riparian woodlands that are at risk from water abstraction. Early warning of potential tree mortality will allow better management of impacts to these important ecosystems, thus protecting the biodiversity in them from over-abstraction.

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