

Groundwater-dependent ecosystems & groundwater availability



NATIONAL CENTRE FOR
GROUNDWATER
RESEARCH AND TRAINING

This resource discusses the relationship between groundwater availability and groundwater-dependent ecosystems, and follows on from an earlier fact sheet which introduces groundwater-dependent ecosystems. It is designed for a general audience.

ECOSYSTEMS AND GROUNDWATER

For groundwater to be of use to trees and other plants, it must be within reach of their roots. Groundwater can sit just above the ground (for example, when it has flowed up into a river or wetland) or it might be deep underground. Generally, in Australia, if there is groundwater within 10 m of the land's surface, it is likely that the tree is using it. There are records of tree roots reaching down to 60 m underground, but this is very very rare and only occurs in certain sorts of soils.

Groundwater depth can vary over time. It might change considerably over relatively short timeframes; for example, around Darwin, in the wet season groundwater might be just 0.5 m below the surface, but at the end of the dry season it might be 8 or 9 m down. The kinds of savannas that are found around Darwin are used to coping with this level of intra-annual variability.

In other places, groundwater levels may vary very little. In Kangaloon, south-west of Sydney, where the NCGRT is focusing research, groundwater depth varies very little, even from year to year. Because of this, we can assume that where groundwater is less than 10 m below ground, the trees in this area are relying upon it, especially in dry years.

GROUNDWATER AVAILABILITY AND VEGETATION STRUCTURE

If we compare two places, one with available groundwater, and one without,



we find that, all else being equal, there will be more 'plant biomass' in areas with groundwater. That is to say: groundwater enables more trees to grow, it enables them to grow more densely, it enables them to grow bigger and it enables them to grow more leaves. So the structure of ecosystems is quite different when groundwater is available.

There are also functional differences in trees which can and cannot access

groundwater. For example, trees which have no access to groundwater tend to have denser wood. Wood density is important because it determines hydraulic architecture – or how easily trees can move water within themselves. Dense wood means that a tree moves water more slowly and will be more drought resistant, and so this is often found in areas without accessible groundwater.

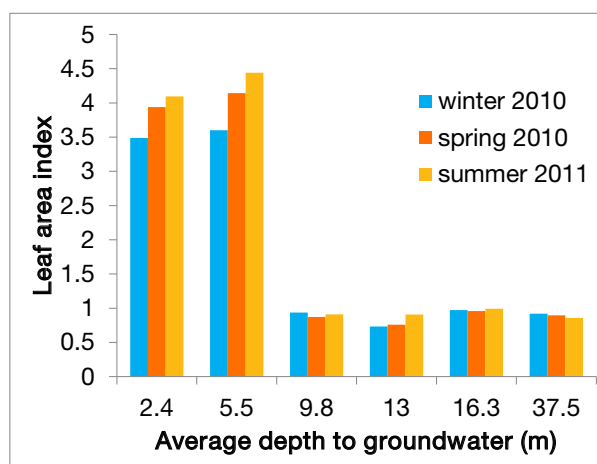


Figure 1. The figure to the left shows how the leaf area index (the ratio of leaf area to ground area) is largest when groundwater is shallow (less than 9 m), but is much smaller when groundwater is deep (10 m or more).

Data from NCGRT researchers Sepideh Zolfaghar and Dr Randol Villalobos-Vega (pictured overleaf).

Want to know more?

One of the NCGRT's five research programs focuses on groundwater–vegetation–atmosphere interactions. Researchers in this program are working on measuring evapotranspiration and groundwater recharge, as well as the sensitivity of groundwater-dependent ecosystems to changes in groundwater levels and chemistry.

To learn more about our projects, visit www.groundwater.com.au

On the other hand, less dense wood, found in areas with reliable groundwater sources, means that trees are more susceptible to drought, but because of their groundwater access, experience less drought. Less dense wood means that, as these trees can more easily move water from the roots to the leaves, they can transpire and photosynthesise more, grow more quickly and store more carbon.

GROUNDWATER AND CO₂

There is a simple rule of thumb in ecohydrology: for every 200–300 molecules of water that a leaf loses through transpiration, it gains one molecule of carbon dioxide.

Plants and trees open the stomata (or tiny pores) in their leaves in order to let in the carbon dioxide they need to complete photosynthesis and grow. The cost of opening the stomata is known as transpiration; that is, plants lose water in the form of water vapour – this is part of the water cycle. So, we can think of trees with good access to groundwater as standing with their feet in a big bucket of water, and as they have access to more water, they spend more water. When more water is available to plants, their productivity goes up, and there is a relationship between the amount of water available and the amount of carbon that a plant can take in.

GROUNDWATER AND REFORESTATION

This relationship between groundwater availability and carbon dioxide is particularly interesting when we begin to think about planting extra trees to absorb carbon: this is limited by the amount of water that is available. If too many trees are planted, rivers may dry up as trees are using the groundwater that would normally have contributed to filling them.



Research was done on measuring the response of pristine woodland to variations in groundwater depth.

The research site for this work, the Kangaloon Borefield, was in an area designated to protect the quality and supply of water in Sydney's southern catchment. Since the borefield is a potential emergency source of water for human use, this research had theoretical implications for sustainable use of the groundwater resource.

This breakthrough research had identified the point where removing groundwater damaged the health of a forest – that is, when the water table drops below ten metres. The optimal groundwater depth for forest health is between six and nine metres. This may be true for most groundwater-dependent ecosystems across Australia, which should be useful for setting sustainable extraction limits.'

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