Understanding groundwater-dependent ecosystems

Background

NATIONAL CENTRE FOR GROUNDWATER RESEARCH AND TRAINING

This resource introduces groundwater-dependent ecosystems: communities of plants and animals that rely on groundwater to survive. It discusses groundwater-dependent ecosystems in Australia, and why they're so important. It is designed primarily for a general readership.

WHAT IS A GROUNDWATER-DEPENDENT ECOSYSTEM?

A groundwater-dependent ecosystem is a community of plants, animals and micro-organisms that relies on the availability of groundwater to maintain its current structure and function.

Groundwater-dependent ecosystems may rely on groundwater all year round, or they might only require groundwater during particularly dry periods, such as droughts.

Many of Australia's most iconic ecosystems are groundwater dependent: wetlands, paperbark swamps and river red gums are just a few examples. Groundwater-dependent ecosystems are increasingly influenced by human activities as our groundwater use increases.

There are three types of groundwater-dependent ecosystems:

Stygofauna

Stygofauna are tiny creatures that live underground in aquifers. In Australia, most stygofauna are crustaceans, but there are also worms, gastropods, beetles, mites and fish. Most can't survive above ground, and rely totally on groundwater – as such, they are very vulnerable to changes in their environment. Over 750 new species of stygofauna have been discovered in Australia in the last 15 years, and Australia is now regarded as one of the world's hotspots for subterranean biodiversity, with an estimated 4000 different species.

Ecosystems reliant on surface expression of groundwater

The second class of groundwater-dependent ecosystems are those that rely on groundwater coming to the land surface. For example, some rivers flow during dry periods only because groundwater is moving into them from the water table. These rivers can be said to be groundwater-dependent ecosystems, both because fish and plants live in the water, but also because riparian forests that grow alongside rivers often rely on the same water.

Many wetlands and the mound springs in Queensland and South Australia are examples of ecosystems that rely on groundwater coming to the surface.

Ecosystems reliant on groundwater within the root zone

Finally, there are some ecosystems which are themselves above ground but rely on groundwater being present underground. Many woodlands and forests are reliant on groundwater, when groundwater is within reach of the roots. In some systems, tree roots can readily access groundwater to depths of 10 m, but in some places this number may be higher or lower.

STRUCTURE AND FUNCTION

So, groundwater-dependent ecosystems rely on groundwater for their structure and function. But what exactly does this mean?

The structure of an ecosystem is the different types of plants and animals that together form a community, and the quantities of each.

For example, if you visit a north Australian savanna, around Darwin perhaps, it will be dominated by two species of eucalypts, with an understory of grasses. On the other hand, if you go to a rainforest, the structure might include five different layers of trees. A desert has a different structure again.

The function of an ecosystem is its everyday behaviour; in plants, this includes taking up carbon every day through

Want to know more?

A team of NCGRT researchers are working at Kangaloon, two and a half hours south west of Sydney, looking at ecosystems with different levels of access to groundwater, but which experience the same temperature and rainfall. From this, they are hoping to find out more about how trees respond to groundwater availability.

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photosynthesis, losing water through transpiration, and cycling nutrients through soils and roots and leaves.

Ecosystem structure and function is very much determined by water availability: it's why the plants in a very wet rainforest are different to a very dry desert. In far north Queensland, where rainfall is 3–4 m annually, the rainforests are 50 m tall and the canopy is very dense. In the arid zone around Alice Springs, where rainfall might be just 350 mm, you will find fewer trees, and the landscape is dominated by Acacia which are more drought resistant.

Water availability determines ecosystem structure and function; as groundwater increases the total amount of water available to plants, it lifts the amount of vegetation, generally through changes in the composition of the vegetation present.

WHY ARE GROUNDWATER-DEPENDENT ECOSYSTEMS IMPORTANT?

Groundwater-dependent ecosystems are important for a number of reasons.

- They contribute to broader ecosystems, for example, they stop soil erosion and they act as corridors for animals to safely migrate.
- They have economic value: tourists like wetlands, they like to see rivers flowing, and recreational fishers like to be able to catch fish.
- There's an aesthetic value to woodlands and forests, and for many people, there's also a cultural and spiritual value.
- They also provide 'ecosystem services': they capture carbon, they intercept runoff from land.

It's for these reasons, among many others, that we need to manage our groundwater, and our groundwater-dependent ecosystems, with care.

TREE CHARACTERISTISCS AND WATER

National Centre for Groundwater Research and Training researchers at the University of Technology, Sydney, are trying to gain a better understanding of groundwater-dependent ecosystems and the relationship between groundwater availability and plant traits, both structural and functional. By comparing the physiology of trees across a depth to groundwater gradient, researchers hope to discover the most important traits for monitoring ecosystem responses to changes in groundwater levels.

Her preliminary results looking at leaf area index (that is, the amount of leaf material above every 1 m^2 of ground), indicate that there is a dramatic drop in leaf material when groundwater is between 6.5 m and 9 m below ground. This means that roots stop being able to access groundwater between 7 and 9 m below ground.

This is an exciting finding, and is probably applicable in most parts of Australia. The bottom line is that if we allow the water table to drop below 8 m, there may be drastic implications for the area's ecosystems.

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