

## Groundwater replenishment



An upland wetland in Kenya. Photo © Geoffrey Howard

The terms *water table*, *groundwater* and *aquifer* are all used in describing the water held in soil and rocks below ground level. An understanding of the difference between them is helpful for appreciating how the water we see on the surface in wetlands is inherently linked to what goes on below ground, potentially affecting the lives and livelihoods of billions of people throughout the world.

The water table is the level below which soil and rocks are permanently wet (or ‘saturated’). The depth of the water table below the ground surface often varies, rising and falling according to seasonal rainfall or the amount extracted by people for drinking water or irrigation. The water below the water table is referred to as groundwater.

An aquifer is the name given to a distinct layer of rock or sediment that holds abundant groundwater in its pores, joints or fissures. Aquifers can be thought of as vast, natural, underground water-storage reservoirs. The groundwater contained in aquifers accounts for over 95% of the world’s available fresh water and provides drinking water to almost a third of the world’s people. In Asia alone, more than a billion people rely on groundwater for drinking, and in Europe it is estimated that 65% of public water supplies come from groundwater sources.

It is often said that wetlands act like nature’s sponges, soaking up rainfall that then filters into the ground. In reality, the relationship between groundwater and wetlands is rather more complicated. Some wetlands may have no contact at all with groundwater – for example a lake that has formed over a thick, impermeable layer of clay – while others owe their very existence to groundwater that has returned to the surface either as springs, or areas of more general seepage.

Still other wetlands occur on permeable sediments overlying aquifers. Here, water from the wetland is able to percolate through the soil and rocks into the aquifer below, playing a vital role in keeping it topped up (or ‘recharged’) so that groundwater continues to be available for other ecosystems and human use. Finally, some wetlands may act as groundwater recharge areas when the water table is low, and as groundwater discharge zones when the water table is high.

### In brief...

- ◆ The water we see in wetlands such as marshes, lakes and streams on the Earth’s surface represents just part of the water cycle, which also includes atmospheric water (clouds, rainfall and snowfall) and groundwater (water held in soil and rocks below the surface).
- ◆ Many wetlands are directly connected to groundwater and play a vital role in regulating the quantity and quality of groundwater, which is often an important source of water for drinking and irrigation of crops.
- ◆ Unsustainable abstraction of groundwater for human use threatens the very existence of some wetlands – as well as recklessly endangering the communities that depend on that water for daily domestic use.
- ◆ At a global scale, groundwater deficits are now significant problems in many countries, including India, China, the USA and the Arabian Peninsula.

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The Ramsar Convention recognizes the importance of links between groundwater and wetlands (both surface and underground), and has produced guidance on groundwater management for wetlands. The Convention also recognizes 'subterranean karst and cave hydrological systems' as a specific wetland type. These underground wetlands are intimately linked to groundwater. The Škocjan Cave Ramsar and World Heritage Site in Slovenia (central/south-east Europe) is an excellent example, containing an underground river fed by rainwater. Here, the water table fluctuates by more than 130 metres! A unique community of plants and animals, specially adapted to these challenging conditions, has developed.

Green Swamp, which covers over 225,000 hectares, has been called 'the liquid heart of Florida' because it recharges the groundwater that supplies numerous springs, ponds, lakes and other wetlands, as well as five major rivers. Green Swamp regulates the supply of fresh water to much of Florida's growing human population, and the outflow of groundwater prevents salt-water intrusion into the aquifer along the heavily developed east and west coasts.

Quite apart from their role in supporting fishing, agriculture and forestry, the Hadejia-Nguru wetlands in northern Nigeria play a vital role in recharging the aquifers used to support dry-season agricultural production, which is dependent on groundwater abstraction for irrigation.

While the use of groundwater to irrigate crops dates back to ancient civilizations, it has grown hugely in scale and intensity over recent decades. Global abstraction of groundwater grew from a base level of 100–150 cubic kilometres (km<sup>3</sup>) in 1950 to 950–1,000 km<sup>3</sup> in 2000. The bulk of this growth is for irrigated agriculture, particularly in Bangladesh, China, India, Iran, Pakistan and the United States, which together account for well over 80% of global groundwater use. This rapid growth in the extent and quantity of groundwater abstraction for irrigation has had negative impacts on wetlands and in some cases has led to damaging economic effects.

The Geropotamou basin in Crete (Greece) covers an area of 600 km<sup>2</sup>. The basin faces a severe groundwater resources problem due to overexploitation of the aquifer, mainly for irrigation of 250 km<sup>2</sup> of agricultural land. A dramatic drop of 35 metres in groundwater levels occurred during the last three decades of the 20th century, caused mainly by the rapid growth of unregulated pumping of groundwater for irrigation of olive trees. Not only has this led to tension between water users, but former spring-fed wetlands that used to sustain rich biodiversity have disappeared.

Over-extraction of groundwater in the Hai River basin, north-east China, affects an area of 90,000 km<sup>2</sup>. Lake Baiyangdian, known as the 'pearl of the north', has dried up on seven occasions since the 1960s, once for a period of five years. Excessive pumping of groundwater also causes land shrinkage and subsidence, with ground levels dropping by up to 3 metres in parts of Tianjin Municipality (China's sixth largest city). One area of 8 km<sup>2</sup> now lies below sea level.

The natural recharge function of the former 3,600-hectare freshwater marsh and seasonal lake of Gareet El Haouaria in Tunisia (North Africa) depended upon inundation by winter rains. The wetland was drained in the 1960s and the 'reclaimed' land used for farming of rain-fed wheat in winter and crops irrigated with groundwater in summer. As a consequence of destruction of the wetland and its groundwater recharge function, along with increasing abstraction from the aquifer, the water table had fallen 9 metres by 1990, saline intrusion and soil salinization were widespread, and families were forced to abandon their wells and the farms that depended on them.

At a global scale, groundwater deficits are now significant problems in many countries, including China, India, the USA and the Arabian Peninsula, raising fears for drinking-water supplies and food security, as well as for the well-being of wetland ecosystems and the human livelihoods, plants and animals that depend on them.



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