Report on groundwater hydrology and management

Environment, Water

Sedimentary rock is a mixture of fine or coarse grained mineral particles that have been compressed over millions of years. They are often highly permeable, have varying porosity, and promote the movement of water though their pore spaces. These materials form aquifers in ground and can sometimes span vast areas at significant thicknesses. Hydraulic conductivity is dependent upon the type of mineral that water is moving through. As water passes downwards through the rock matrix it may dissolve the mineral in contact with it and subsequently create fractures or caverns; we sometimes witness these as sinkholes on the surface. Igneous or metamorphic rock generally has low porosity and greater density, meaning water cannot easily penetrate its material. It mainly does so through existing fractures created by erosion or earthquakes. These rocks form aquitards and restrict groundwater moving further downwards.

Groundwater occurs in many ways beneath the Earth’s surface. The unsaturated zone or vadose zone is the immediate layer beneath this surface where soil is filled with air and water. When precipitation reaches the ground some of it percolates through this zone to accumulate as groundwater, yet it remains mostly dry in comparison to the saturated zone, better known as the phreatic zone. This zone is located below the watertable and is completely saturated with water. The capillary fringe is wedged in between these two zones, although, just above the water table. Here, water is held by capillary action; a feature of surface tension that pulls water upwards. Water is subject to a large degree of changes as it passes through these contrasting regions. Such changes affect temperature, pressure, composition, acidity (pH), salinity and more.

Water in the Great Artesian Basin is currently experiencing many management problems. One is the declining pressure of water within the basin itself. Under natural conditions, water located at great depth, such as in this case, is under high pressure and when tapped will rise to the surface. However, over-extraction in some regions is causing this pressure to drop, creating problems as manual extraction is more expensive and reliable water resources are a scarcity in Australia. Two is a problem of illegal extraction of water. In some areas of Australia groundwater from the basin is removed without approval or entitlement to the resource. Pinpointing the culprits is an ongoing struggle as there is little way to trace the source of extraction. And three is a problem of salinity. Groundwater can become saline in areas of intense agriculture or as water passing through aquifers becomes saltier.

Empirical groundwater models are based on experimental data. Theoretical knowledge does not apply to these kinds of models and only what has been observed can be used to predict outcomes. Because empirical models are developed from results pertaining to a specific study area they are often limited in their capabilities to accurately predict outcomes in other areas. Because of this drawback these models are sometimes unreliable, however, they do provide useful knowledge on patterns noticed across particular sites. Mathematical models on the other hand are deterministic, in that there is no randomness involved. These models accurately represent the real world as they are designed to move beyond the physical characteristics of a real-life situation. They too are developed from field observations, yet they use

mathematical knowledge to gain perspective on working systems instead of sticking to solely what has occurred before, such as with an empirical model.

Groundwater Dependent Ecosystems or GDEs play an important role in sustaining a plethora of life. Aquatic ecosystems such as lakes, rivers, wetlands, or springs rely on the discharge of fresh water into their environment to support things like baseflow, good water quality, reliable passages to nearby areas, and space which encourages feeding and breeding success. Terrestrial ecosystems such as riparian vegetation in arid regions may exist solely on the existence of groundwater from which it draws up through its roots to maintain cellular activity. This in turn supports life at a microbial scale and beyond. Subterranean ecosystems such as in caves or aquifers completely support life through groundwater. Species that have likely evolved in these inhospitable conditions are only adapted to function here. Subterranean GDEs are an example of obligative dependency in which life would not exist in the absence of groundwater.