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Editorial

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Perched Water Tables Associated with the Vadose Zone

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Introduction

The vadose zone stretches through the soil zone and intermediate zone and incorporates the complete capillary fringe where the medium is still below saturation, gradually becoming saturated towards the water table. This incorporation of the capillary fringe is occasionally questioned due to the saturated nature of the bottom part, but majority of sources agree that the vadose zone is primarily at pore pressures below atmospheric and only secondarily to be mainly unsaturated. The vadose zone can also be considered as “the zone between the land surface and the water table” which includes the plant root and intermediate zones and the capillary fringe, representing that portion of the crust where the pore spaces contain water at pressures below atmospheric, air and other gases. The water table represents the boundary between the phreatic and vadose zones as well as the surface where pressure equals atmospheric. The water table is represented by the water level in a well to account for the deviation from the water table due to any capillary effects absent in the borehole or well itself as well as the often irregular water table in the aquifer material itself. Saturation occurs slightly above the water table due to the capillary fringe, but the rule of thumb is to measure the water level and use that value. Perched water tables are often associated with the vadose zone, depending on the vertical heterogeneity of the subsurface materials. Saturation entails the water content equal to the porosity; viz. all pore spaces are filled completely with water. This applies to the phreatic zone, but also to the lower portion of the capillary fringe where water is being pulled upward due to negative pore water pressures. The saturation of the bottom part of the capillary fringe is not due to the same mechanisms as the phreatic zone and – for this reason – is considered saturated but above the water table. Additional to the above definition of subsurface water is also water in unconnected pores and water that is in a chemical combination with a rock or its component minerals. This unconnected pore water in combination with the vadose and phreatic water is collectively referred to as interstitial water.

The vadose zone falls within a framework overlapping between and combining the specialization of many different disciplines. Having primarily developed at the hand of soil science related to the plant root zone through which plant available water and nutrients cycle, the study of vadose zone hydrology has grown considerably. Vadose zone hydrology includes the specialist input of notably soil scientists, surface water hydrologists, hydro geologists and engineering geologists, but such collaborative efforts are still mostly limited to the implications of soil water on biodiversity or the protection offered to the aquifer by the overlying unsaturated media, and hence closely linked with studies in geotechnical engineering and ecology.
Water is important in construction in that surface water causes erosion and flooding, and groundwater controls effective stress and frictional strength. Changes in groundwater conditions induced by engineering mobilize water and can possibly also cause internal erosion, increasing effective stress and self-weight compaction of earth materials. Rising water levels may furthermore weaken the ground supporting structure due to, for instance, dissolution of cementing materials. Atterberg limits – relating moisture content to soil consistency – are important engineering parameters with notable respect to cohesive soils and influence decisions regarding use of onsite materials, stabilization and anticipated geological problems.

The hydrological cycle is an intricate interaction between water from the atmosphere, Earth surface and subsurface. Conventional hydrogeology is mainly interested in recharge which can be defined as water eventually reaching the saturated zone or as that process whereby water infiltrates through the vadose zone, eventually reaching the groundwater surface and adding water to the aquifer, occurring as the net gain from precipitation or runoff. The problem, however, is recharge estimation. The present day understanding of recharge processes has been summarized, concluding that intrinsic limitations occur with the well-established methods of recharge estimation and that climate is not the only parameter of importance, but also the surface and subsurface conditions which incorporate lithology, palaeoclimate and palaeohydrological evolution.

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