ECOHYDROLOGY & HYDROBIOLOGY

DOI:10.2478/v10104-009-0030-z
Vol. 8
No 2-4, 385-389
2008

Ecohydrological Processes and Sustainable Floodplain Management

The importance of unsaturated soil zone for the regional water balance

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Abstract

Studies of the soil water balance, especially the function of the unsaturated soil zone, infiltration rate was made on two very different sites: Marchfeld (Vienna basin, 170 m asl, 550 mm precipitation and 9.5°C mean annual temperature), and in the Radstädter Tauern (Country of Salzburg, 1600 m asl. 1500 – 2000 mm precipitation, 2-5°C mean annual temperature). The results demonstrate the big influence of human activity - like intensive agriculture or exaggerated creation of ski slopes - in positive sense: a sustainable land management in the Marchfeld, and negative sense: decrease of the water capacity due the destroying of the topsoil.

Key words: soil water balance, infiltration rate, unsaturated zone, Marchfeld, Obertauern.

1. Introduction

Water is a one of the most important environmental issues in 21st century: water being not available in sufficient quantity and adequate quality to the people in some regions of the earth, or water being insufficient for agriculture due to lack of rainfall, or not enough water being available for irrigation. The present fear of climate change and the potential water scarcity involved enrich this discussion even further.

Little or no attention is given, however, to the water present in the soil and the soil's function as a filter and storage medium. The soil is not only the basis of nourishment and renewable energy, but it is of vital importance as a retention zone for precipitation water. This function will be discussed in greater detail in the following paragraphs.

Water balance of a vegetated location is presented in Fig. 1.

Water is supplied to the soil in various forms, such as rain, snow, hail, dew and frost, often reduced by interception through plants, notably under forest cover, possibly in substantial amounts. Water reaching the ground surface penetrates the soil more or less rapidly. However, where surface crusting or soil compaction prevent it from penetrating the soil, it becomes lost to the locality through evaporation or lateral runoff.

That water which does penetrate the soil fills up pores of decreasing diameter, is stored there and can be taken up by plant roots, flow off or evaporate. This unsaturated soil zone serves both as a regulating agent and as a storage medium and as such governs the water balance of the soil. This storage capacity enables this soil zone to supply sufficient water to plant life during climatic droughts, thus mitigating or even eliminating stress to the plants. Excess water percolates downward to the water table so as to fulfil a further function, recharge, which is not directly tied to the

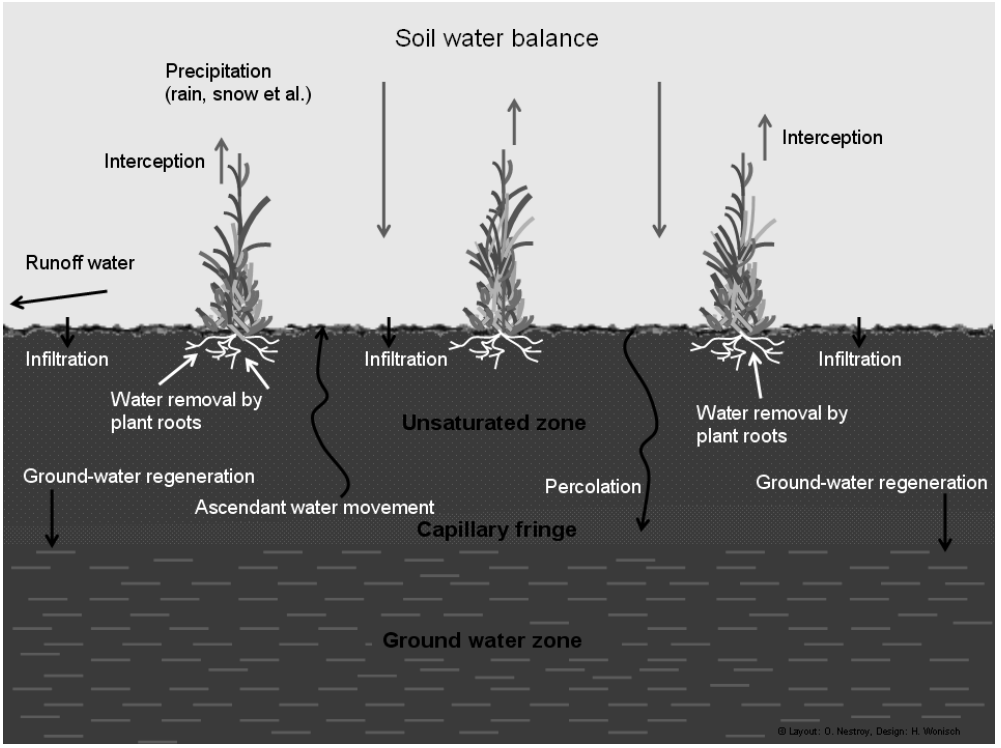

Fig. 1. The soil water balance.

soil. The filtration and storage capacity of the soil play an important role in groundwater renewal.

At slope locations, surface erosion and the presence of a first water table immediately below the ground surface – the interflow zone – come in as additional factors to be considered.

A soil with a high effective field capacity (of more than 140 mm), while usually being capable of supplying sufficient water to plant life even when rainfall is irregular or scarce, shows a certain vulnerability to erosion and contributes little to groundwater renewal.

A location with only medium effective field capacity (of 90–140 mm) is actually vulnerable to erosion during heavy rainfall and has an important share in groundwater renewal. Yields will not rise beyond average even in the case of great rainfall volumes and will be below average when rainfall is scarce.

Slope locations of low effective field capacity are extremely vulnerable to erosion during heavy rainfall. They are, in fact, efficient suppliers to the water table but may fail to ensure adequate filtration. The productivity at such locations will be below average or poor.

The relationships shown in the Table I have been tested in the field.

2. Study sites and results

Studies have been conducted in two different regions: Locations 1 and 2 are in the Marchfeld plain northeast of Vienna, a region at

Table I. Soil water balance, erosion risk and yield potential.

Soil water storage	high			medium			low		
Precipitation	high	medium	low	high	medium	low	high	medium	low
Erosion risk	low	low	low	high	medium	low	very high	high	medium
Groundwater recharge	low	low	very low	medium	medium	low	very high	medium	low
Yield potential	high	medium	low	medium	medium	low	medium	low	very low