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Vadose Zone Hydrology and Eco-hydrology in China

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Vadose zone hydrology has long been a concern regarding groundwater recharge, evaporation, pollution, and the ecological effects induced by groundwater and water & salt contents in the unsaturated zone. The greater difference between day and night temperatures in arid and semi-arid areas influences water movement and heat transport in the vadose zone, and further influences the water and heat fluxes between the water table and the atmosphere as well as ecological environment. Unfortunately, these studies are lack in a systematic viewpoint in China. One of the main reasons is that the movement of water, vapor and heat from the surface to the water table is very complex in the arid and semi-arid areas. Another reason is lack of long term field observations for water content, vapor, heat, and soil matrix potential in the vadose zone. Three field observation sites, designed by the author, were set up to measure the changes in climate, water content , temperature and soil matrix potential of the unsaturated zone and groundwater level under the different conditions of climate and soil types over the period of 1-5 years. They are located at the Zhunngger Basin of Xinjing Uygur Autonomous Region in northwestern China, the Guanzhong Basin of Shaanxi Province in central China, and the Ordos Basin of the Inner Monggol Autonomous Region in north China, respectively. These three field observation sites have different climate and soil types in the vadose zone and the water table depth are also varied. Based on the observation data of climate, groundwater level, water content, temperature and soil matrix potential in the vadose zone from the three sites in associated with the field survey and numerical simulation method, the water movement and heat transport in the vadose zone, and the evaporation of phreatic water for different groundwater depths and soil types have been well explored. The differences in water movement of unsaturated zone between the bare surface soil and vegetation conditions were also compared. The concept of the ecological value of groundwater and unsaturated zone is presented in arid and semi-arid regions. This ecological value can be reflected in four aspects:(1) the maintenance of base flow in streams and areas of lakes and wetland;(2) the supply of physiological water demented by vegetation;(3) the regulation of soil moisture and salt content; and (4) the stability of the eco-environment. In addition, the threshold system between the ecological environment and multi-dimensional indices as variations in water and salt contents in the vadose zone, groundwater depth and quality as well as groundwater exploitation, are proposed in the arid and semi-arid areas. It is expected that this research could provide a scientific basis and technological support for better understanding on the movement of water, vapor and heat in the vadose zone in arid and semi-arid areas. It will also help to maintain sustainable development of the ecological environment and utilization of water resources.