Geophysical Research Abstracts
Vol. 17, EGU2015-4575-1, 2015
EGU General Assembly 2015

Groundwater Recharge and Flow Processes in Taihang Mountains, a Semi-humid Region, North China

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Groundwater flow/recharge variations in time and space are crucial for effective water management especially in semi-arid and semi-humid regions. In order to reveal comprehensive groundwater flow/recharge processes in a catchment with a large topographical relief and seasonal hydrological variations, intensive field surveys were undertaken at 4 times in different seasons (June 2011, August 2012, November 2012, February 2014) in the Wangkuai watershed, Taihang mountains, which is a main groundwater recharge area of the North China Plain. The groundwater, spring, stream water and reservoir water were taken, and inorganic solute constituents and stable isotopes of oxygen-18 and deuterium were determined on all water samples. Also, the stream flow rate and the depth of groundwater table were observed.

The stable isotopic compositions and inorganic solute constituents in the groundwater are depleted and shown similar values as those of the surface water at the mountain-plain transitional area. Additionally, the groundwater in the vicinity of the Wangkuai Reservoir presents clearly higher stable isotopic compositions and lower d-excess than those of the stream water, indicating the groundwater around the reservoir is affected by evaporation same as the Wangkuai Reservoir itself. Hence, the surface water in the mountain-plain transitional area and Wangkuai Reservoir are principal groundwater recharge sources.

An inversion analysis and simple mixing model were applied in the Wangkuai watershed using stable isotopes of oxygen-18 and deuterium to construct a groundwater flow model. The model shows that multi-originated groundwater flows from upstream to downstream along topography with certain mixing. In addition, the groundwater recharge occurs dominantly at the altitude from 421 m to 953 m, and the groundwater recharge rate by the Wangkuai Reservoir is estimated to be 2.4 % of the total groundwater recharge in the Wangkuai watershed. Therefore, the stream water and reservoir water in the mountain-plain transitional area plays an important role of groundwater recharge in semi-arid and semi-humid regions.