Geophysical Research Abstracts, Vol. 7, 03736, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03736

Vegetation, climate change, and diffuse groundwater recharge in arid and semiarid environments

E. Small

Department of Geological Sciences, CU Boulder, USA

Several different types of data show that there is currently little or no diffuse groundwater recharge at many arid and semiarid sites worldwide. However, evidence for diffuse recharge has been found at some sites where mean annual precipitation (P) is much less than mean annual potential evapotranspiration (PET), particularly where soils are coarse and hydroclimatic conditions are variable. In addition, there is evidence suggesting that diffuse recharge was widespread during the last glacial period, likely a result of the climate or vegetation (or both) at that time. We investigate how vegetation and climate control the rate of diffuse groundwater recharge using a one-dimensional, liquid-only flow model for desert vadose zones. The flow model is driven by a stochastic parameterization of climate at a point that includes storm size distribution and seasonality of precipitation and potential evapotranspiration, constrained by data from over 700 climate records from the southwestern U.S. The type of vegetation is varied to investigate how constraints on transpiration resulting from physiological and phonological limitations impact recharge.

Strom size distribution and seasonality control the frequency of intervals when P exceeds PET and the amount of water that accumulates in the root zone during these intervals, which in turn controls the flux out the bottom of the root zone. Climates with larger and more infrequent storms yield recharge at lower values of P/PET. Seasonality has a larger influence on recharge than storm size distribution, and the effects are similar for both coarse and fine soils. The relative timing of P and PET maxima is critical: recharge occurs at P/PET values that are lower by 0.2 when the rainy season occurs during the winter instead of the summer. The type of vegetation also provides a critical control on recharge. In particular, when plant phenology excludes transpiration during part of the year, recharge occurs at much lower values of P/PET. In contrast, the most negative water potential at which a plant can sustain transpiration has little

impact on recharge, at least for the desert species studied. Finally, interactions between climate and vegetation change are critical to explain the long-term variations in diffuse recharge observed in arid and semiarid regions worldwide.