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Transpiration by tree roots in the deep unsaturated regolith buffers the recharge process in a tropical watershed under deciduous forest (Mule Hole, India)

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Accurate estimations of water balance are needed in semi-arid and sub-humid tropical regions, where water resources are scarce compared to water demand. Evapotranspiration plays a major role in this context, and the difficulty to quantify it precisely leads to major uncertainties in the groundwater recharge assessment, especially in forested catchments where deep tree root can uptake water at considerable depth.
In this presentation, we assess the importance of deep unsaturated regolith and water uptake by deep tree roots on the groundwater recharge process by using the lumped conceptual model COMFORT (Ruiz et al., 2010) to simulate discharge and groundwater levels monitored during six year in an experimental watershed under dry deciduous forest (Mule Hole, South India), which is part of the project “Observatoire de Recherche en Environnement – Bassin Versant Expérimentaux Tropicaux” (http://www.ore.fr/). The model was calibrated on the first four years data, and tested on the two remaining years.
The model was able to simulate the stream discharge as well as the contrasted behaviour of groundwater table along the hillslope. Water balance simulated for a 32 year climatic time series displayed a large year-to-year variability, with successions of dry and wet phases with a time period of approximately 14 years. On an average, input by the rainfall was 1090 mm.year-1 and the evapotranspiration was about 900 mm.year-1 out of which 100 mm.year-1 was uptake from the deep regolith horizons. The stream flow was 100 mm.year-1 while the groundwater underflow was 80 mm.year-1.
The simulation results show that i) deciduous trees can uptake a significant amount of water from the deep regolith, ii) this uptake, combined with the spatial variability of regolith depth, can account for the variable lag time between drainage events and groundwater rise observed for the different piezometers, iii) water table response to recharge is buffered due to the long vertical travel time through the deep vadose zone, which constitutes a major water reservoir. These results are of practical relevance as they invalidate recharge assessment methods based on steady state assumptions in this context. This study stresses the importance of long term observations for the understanding of hydrological processes in tropical forested ecosystems.

Ruiz L, Varma MRR, Mohan Kumar MS, Sekhar M, Maréchal JC, Descloitres M, Riotte J, Sat Kumar, Kumar C and Braun JJ 2010 Water balance modelling in a tropical watershed under deciduous forest (Mule Hole, India) : regolith matric storage buffers the groundwater recharge process. Journal of Hydrology, 380, 460-472. http://dx.doi.org/10.1016/j.jhydrol.2009.11.020