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Extended Abstracts

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Keynote lectures

title: **Underestimated role of tree transpiration and groundwater evaporation in groundwater balancing and modelling**

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Field isotope experiments confirm that many tree species (phreatophytes) capture groundwater by roots to survive (Lubczynski, 2009). This process is called transpiration from groundwater or shorter groundwater transpiration (T_g). A combination of field experiments and modeling show also that groundwater can be discharged by evaporation directly from water table or capillary fringe (Gowing et al., 2006; Lubczynski, Gurwin, 2005). This process is called groundwater evaporation (E_g). The sum of T_g and E_g called groundwater evapotranspiration is typically underestimated in hydrology and hydrogeology despite in many environments significantly affects groundwater balances.

The T_g and E_g, next to recharge (R), are spatio-temporally variable fluxes. In contrast to R, relevant mainly in rainy season, the T_g and E_g are significant in dry seasons when surface water is unavailable and shallow soil moisture negligible. The T_g and E_g are driven by water stress and vapor pressure deficit, therefore affect mainly dry, water limited environments (WLE). In general, the more arid environments and drier conditions, the more important role of T_g and E_g in groundwater balances is. Besides, the T_g and E_g depend also on the hydrogeological conditions, mainly lithological composition and texture of unsaturated zone and groundwater table depth.

The hydrogeological importance of T_g will be presented by explaining: (i) interactions between trees and groundwater, emphasizing tree groundwater dependence due to hydraulic redistribution process; (ii) environmentally dependent tree adaptation processes, comparing root water uptakes in shallow (few meters) water table condition of Spain with root water uptakes in deep (few tenths of meters) water table condition of Kalahari Desert; (iii) state of art in experimental assessment of total tree transpiration by sap flow measurements; (iv) state of art in partitioning of tree transpiration into groundwater and unsaturated zone components by using combination of sap flow and isotope measurements; (v) potential of mapping T_g by remote sensing upscaling of field transpiration measurements.

The hydrogeological importance of E_g will be presented by explaining: (i) complexity of liquid and vapor water transport in the unsaturated zone, including experimental assessment and modeling; (ii) dependency of E_g on environmental factors such as climatic aridity, groundwater table depth, unsaturated zone texture etc.; (iii) perspectives and difficulties in extracting E_g from total evaporation; (iv) potential of mapping E_g by remote sensing upscaling.

The presentation will be concluded by presenting concept of integration of T_g and E_g in numerical groundwater models using MODFLOW code. The benefits of such integration will be discussed with reference to different environmental constrains. The importance of T_g and E_g integration will be emphasized by comparing water balances and model uncertainties of the proposed integrated solution with the standard MODLFLOW solution.

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