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Impact of irrigation on the surface water-groundwater connections in the lacustrine plain of Lake Tana, Ethiopia

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The Lake Tana Basin of Ethiopia is one of the growth corridors of the country with ambitious water resource development plans. Irrigation affects the hydrological cycle by influencing mainly infiltration and evapotranspiration, which in turn affect the interactions between surface water and groundwater. If the source of irrigation water is not from groundwater pumping, irrigation and subsequent deep percolation rises the groundwater level of a given area and thus affects the groundwater and surface water interactions. A field experiment was carried out (from December 2014 to April 2015) to examine the effect of irrigation on deep percolation and on the surface water-groundwater connections in a typical small-scale irrigation scheme in the lacustrine plain of Lake Tana. Irrigation and deep percolation were quantified and the water table fluctuations following irrigation were characterized. For this research, three experimental fields (each approx. 40 m x 40 m) were selected in a straight line across the irrigation scheme to address the variability of soil and ground water gradients. The amount of irrigation water applied for each irrigation event was measured using wooden V-notch thin-plate weirs and the depth of water table on daily basis were measured using piezometers (5 per experimental field). The water table fluctuation method was used to estimate shallow groundwater recharge due to irrigation-induced deep percolation. On average 471 ($\pm$33) mm irrigation water was applied in 12-15 events; no rainfall occurred during the irrigation period, and crop grown was onion. Water level rises (0.02-0.56 m) were observed in all the three fields following every irrigation event. The amount of recharge from irrigation deep percolation was influenced by irrigation depth (0.05 and 0.56 m rise was observed following 23 and 44 mm irrigation respectively); towards the end of the irrigation season, and despite greater irrigation depths, the increased seasonal temperature (from 26 ^{o}C in December to 31 ^{o}C in April) and crop growth resulted in larger evapotranspiration (from 2.5 mm/day in December to 4 mm/day in March), hence decreased deep percolation which led to an overall lowering of the water tables and to a rapidly decreasing lateral outflow in the river bank at the edge of the irrigation scheme (from 0.049 l/s on 2 February to 0.002 l/s on 21 March). The deep percolation after irrigation appeared to be a significant source of groundwater with a seasonal recharge of 11 to 14% of the applied irrigation water. This evidences that in the study area the hydrological regime is strongly affected by irrigation, but also that there is much room for improvement of the efficiency of irrigation practices.