Geophysical Research Abstracts
Vol. 18, EGU2016-16462-2, 2016
EGU General Assembly 2016

Analyses of surface and groundwater flow characteristics of the Ljubljana moor and water resources vulnerability to climate and land use change and groundwater overdraft

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One of the biggest water resource of Slovenian capital is groundwater of Ljubljana moor (Ljubljansko barje) aquifer. Quantity and quality of groundwater in Ljubljana moor aquifer directly depend on precipitation, surface water and riparian ecosystems of the Moor and indirectly by groundwater recharge from higher-lying mountainous karstic areas of forests and grasslands. Maintaining high groundwater level of the Ljubljana moor not only sustain stable water balance of aquifer, but also its riparian and wetland character. It also inhibit larger subsidence of the terrain. The paper addresses the vulnerability of the Ljubljana moor water resources to climate and land use change and due to groundwater overdraft. The results should help in selecting suitable mitigation measures and management of the Ljubljana moor area.

We analyze surface and groundwater flow characteristics of water recharge area of one water work on the Ljubljana moor (Brest) from the point of view of climate change, changes in land use and water pumping practices. The Iška River, a tributary to the Ljubljanica River, recharges the area in the gravel bar, which lies just below the hills. We use existing data of meteorological, hydrological and hydrogeological monitoring and simulate rainfall-runoff processes. We use a conceptual semi-distributed rainfall-runoff model HBV-Light and simulate hydrological characteristics of the Ljubljana Moor (groundwater level fluctuations and recharge, surface – groundwater interchange) with two hydrodynamic models, DHI MIKE FLOOD (surface flow, 2D simulation) and DHI MIKE SHE (groundwater flow). For a calibration of runoff model HBV Light and MIKE SHE we use measured daily discharge data of the river Iška (1970-2010) and groundwater level data along the river (2010-2013) respectively. In groundwater modelling, we include the data of water pumping. Daily precipitation and temperature for period 2020 – 2050 are from ESAMBLE project for two GCM climate scenarios. We have prepared two land use changes scenarios for the Iška river catchment as an input data to model “swbEWA” (soil water balance for European Water Accounting) developed at European Environment Agency (Kurnik et al.,2014). In that model one climate scenario represents low impact to soil moisture and water balance (model 1), the other high impact (model 2).

The modeling results show that there will be 20% lower annual runoff and 45% lower autumn and spring runoff under climatic model 2. Upper soil layer will have 35% less water on annual bases (drop in all months). Between October and February, the discharge of the Iška River will be lower for 24%, and 13% lower in the rest of the year. Groundwater level will drop in average for 40 cm on Ljubljana moor and 25 cm in the Iška river gravel fan. Recharge of groundwater in lower zones will drop for 18 % on average if the present pumping practice continues. We may expect reduction of available water resources for drinking water supply, larger drainage of wetland and significant subsidence of the aquifer.