Geophysical Research Abstracts
Vol. 17, EGU2015-9996, 2015
EGU General Assembly 2015

Sublacustrine groundwater discharge in esker aquifers; fully integrated groundwater flow modeling compared with novel field techniques

Pertti Ala-aho, Pekka M. Rossi, Elina Isokangas, and Bjørn Kløve
Water Resources and Environmental Engineering Reserach Group, University of Oulu, Oulu, Finland (pertti.ala-aho@oulu.fi)

Groundwater (GW) discharge to surface water bodies such as streams, lakes and wetlands can greatly affect their water quantity, quality and related aquatic ecology. Therefore better understanding of GW – surface water interaction is needed in integrated management of water resources. Sublacustrine groundwater discharge (SGD) to lakes was studied in a complex unconfined Rokua esker aquifer system. SGD was studied for 12 lakes in the area to better understand water and solute inputs through lake beds and thereby the role of GW on lake water budget and solute concentrations.

The locations and fluxes of SGD were simulated using a fully integrated groundwater flow model Hydro-GeoSphere. The used hydrological simulator allows water to flow and partition into overland and stream flow, evaporation, infiltration, and subsurface discharge into surface water features in a physically-based way, which was needed in simulating SGD of the complex aquifer system. The model was first calibrated for subsurface hydraulic conductivity in steady state using data of measured long-term average groundwater and lake levels and stream baseflow. The model performance in transient simulations was then examined against recorded hydrographs for lake and groundwater levels and stream flow.

After model performance was verified, the simulated locations and fluxes of SGD were extracted from the model and compared with results from three independent field methods: airborne thermal imaging, stable isotope water balance and seepage meter measurements. Airborne thermal imaging was used to infer locations of SGD into lakes based on temperature anomalies at lakes shorelines due to discharging cold groundwater. Isotopic composition (H2 and O18) was analysed for lake water, groundwater and the data was used to estimate SGD flux into lakes. Finally, seepage meter measurements were conducted for one of the lakes to establish both locations and fluxes of SGD in detail.

The simulated and field-based estimated of SGD fluxes and locations compared favourably between the used methods. General pattern of the observed SGD locations using areal thermal imaging was reproduced by the simulations. Order of magnitude in the SGD fluxes agreed between the simulations and stable isotope method, though the isotope-based estimates were consistently higher. The novelty of work was in identifying and quantifying SGD in an esker aquifer using several field based methods and a state of the art modeling approach. The results confirmed that GW is an important component of lake water balance in the area, and likely plays a significant role in solute inflow to lakes and thereby lake trophy status. The study produced new information water fluxes at groundwater and surface water interface in esker aquifers, which is needed in integrated water resource management of these complex aquifer systems.