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Modelling the effect of buried valleys on groundwater flow: case study in Ventspils vicinity, Latvia

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Buried subglacial valleys are widely distributed in glaciated regions and they can have great influence on groundwater flow and hence on groundwater resources. The aim of this study is to evaluate the effect of the buried valleys on groundwater flow in a confined aquifer (Middle Devonian Eifelian stage Arukila aquifer, D2ar) applying numerical modelling.

The study area is located at vicinity of Ventspils Town, near wellfield Ogsils where number of the buried valleys with different depth and filling material are present. Area is located close to the Baltic Sea at Piejūra lowland Rinda plain and regional groundwater flow is towards sea. Territory is covered by thin layer of Quaternary sediments in thicknesses of 10 to 20 meters although Prequaternary sediments are exposed at some places.

Buried valleys are characterized as narrow, elongated and deep formations that is be filled with various, mainly Pleistocene glacigene sediments - either till loam of different ages or sand and gravel or interbedding of both above mentioned. The filling material of the valleys influences groundwater flow in the confined aquifers which is intercepted by the valleys. It is supposed that glacial till loam filled valleys serves as a barrier to groundwater flow and as a recharge conduit when filled with sand and gravel deposits.

Numerical model was built within MOSYS modelling system (Virbulis et al. 2012) using finite element method in order to investigate buried valley influence on groundwater flow in the study area. Several conceptual models were tested in numerical model depending on buried valley filling material: sand and gravel, till loam or mixture of them. Groundwater flow paths and travel times were studied.

Results suggested that valley filled with glacial till is acting as barrier and it causes sharp drop of piezometric head and downward flow. Valley filled with sand and gravel have almost no effect on piezometric head distribution, however it this case buried valleys encourage groundwater recharge from shallower aquifers. Modelling results with and without valleys shows that buried valleys affect piezometric head in narrow zone around valley. Sand and gravel filled buried valleys recharges confined aquifer with relatively “new” water, thus creating high vulnerability zones in the study area.

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