Geophysical Research Abstracts
Vol. 15, EGU2013-2389, 2013
EGU General Assembly 2013

Comparison of upconing under vertical and horizontal wells in freshwater lenses: sand-box experiments and numerical modeling

Leonard Stoeckl (1), Loeffler Stefan (2), and Georg Houben (1)

(1) Federal Institute for Geosciences and Natural Resources (BGR); Stilleweg 2; 30655 Hanover (leonard.stoeckl@bgr.de), (2) Friedrich Schiller University Jena; Humboldtstr. 11; 07743 Jena

Freshwater lenses on islands and in inland areas are often the primary freshwater resource there. The fragile equilibrium between saline and fresh groundwater can be disrupted by excessive pumping, leading to an upward migration of the saline water underneath the well. Sand-box experiments were conducted to compare the upconing at vertical and horizontal wells pumping from a freshwater lens. Results were then compared to numerical simulations.

To simulate the cross-section of an “infinite strip island”, an acrylic box with a spacing of 5 cm was filled with coarse sand. After saturating the model with degassed saltwater from bottom to top, freshwater recharge was applied from above. By coloring the infiltrating freshwater with different tracer colors using uranine and indigotine we were able to visualize flow paths during pumping. A horizontal and a vertical well were placed at the left and right side of the symmetric island. Both had equal diameter, screen length, depth of placement, and distance to shore. Three increasing pumping rates were applied to each well successively and the electrical conductivity of the abstracted water was continuously measured using a through-flow cell.

Results show that no saltwater entered the wells when pumping at the lowest rate. Still, slight saltwater up-coning and a shift of the freshwater divide in the island were observed. At the second rate a clear saltwater breakthrough into the vertical well occurred, while the electrical conductivity remained nearly unchanged in the horizontal well. Applying the third (highest) abstraction rate to each of the wells saltwater entered both wells, exceeding drinking water standards in the vertical well.

The described behavior indicates the advantage of horizontal over vertical wells on islands and in coastal zones prone to saltwater up-coning. Numerical simulations show similar patterns, even though deviations exist between the second and the third pumping rate, which are under and overestimated by the numerical simulation, respectively. Further investigations are necessary to investigate the dynamics of pumping from freshwater lenses under the influence of climate change (i.e. sea level rise).