Numerical modelling of tsunami-induced seawater intrusion and aquifer recovery process in the Niijima Island, Japan

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As reported after the 2004 Indian Ocean earthquake and the 2011 Great East Japan earthquake, the tsunami inundations can result in great damages to coastal aquifers by introducing massive saltwater into subsurface. The devastated salinization of groundwater resource can cause unexpected and strongly disturb local water supply. In order to secure water supply after tsunami events, assessment of tsunami-induced seawater intrusion to coastal aquifers is of great significance. In this paper, we presented a case study of the Niijima Island which is located in a tsunami-prone zone in Japan and is facing the risk of being attacked by a devastated tsunami within the next 30 years (Cabinet Office, 2011). A three-dimension (3-D) numerical model characterizing the groundwater system of the Niijima Island was developed using the FEFLOW code which can solve both density-dependent groundwater flow and saturated-unsaturated flow problems (Cabinet Office, 2011). Based on this model, we numerically simulated tsunami-induced seawater intrusion and aquifer recovery process on the Niijima Island. The effects of dispersivity and anisotropy ratio of hydraulic conductivity on modelling results were investigated. It was found that bedrock topography strongly influence the movement of the intruded saltwater plume. In order to evaluate the feasibility of utilizing the survived groundwater in the non-tsunami affected area, we modeled the aquifer with pumping behaviors in post-tsunami period. Since groundwater is currently the only freshwater source supporting the Niijima Island, this study can provide suggestions on tsunami disaster prevention and strategies of supplying freshwater for long-term recovery based on these numerical modelling results. This approach also has implications for the disaster preparedness regarding to tsunamis and tsunami-like events such as storm surges on other coastal areas.

Keywords: Numerical modelling, Tsunami, Groundwater

