Popular science summary

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Barrier well can control saltwater intrusion

Coastal regions are suffering from groundwater salinization caused by saltwater intrusion. Salinized groundwater becomes unsuitable for drinking and agricultural purposes. In addition, as predicted by the IPCC's fifth assessment report in 2013, sea level will rise by an 82 cm between 2006 and 2100 in the worst scenario. The sea level rise will further advance saltwater intrusion towards the inland. Under these circumstances, saltwater pumping by a barrier well is gathering attention as a solution for salinization problem. As installing the barrier well in actual fields, it is important to investigate the possible pumping amount from an inland production well to keep the freshwater supply for the regions, especially in arid and semi-arid regions depending on groundwater source. Moreover, there is a possibility to control saltwater intrusion by changing pumping ratio between barrier and production wells. Thus, in this study, the effect of different pumping ratio on the behavior of saltwater intrusion was investigated through lab-scale experiments and numerical modeling.

In lab-scale experiments, an experimental model was created and used to simulate saltwater intrusion under the unconfined coastal aquifer condition. This model had two extraction wells: Barrier well and Production well. The pumping ratio of the pumping rate from the barrier well to that from the production well was changed from 0.9 to 2.6 to examine the critical pumping ratio to avoid salinization of the production well. As a result, when the pumping ratio was less than 1.9, saltwater did not reach the production well. Thus, it is considered that the critical pumping ratio was 1.9, which indicates that the production well can extract 1.9 times amount of groundwater than the barrier well.

As a next step, a two-dimensional numerical model was created to analyze the experimental results. This model can calculate saltwater movement under the same condition as the lab-scale experiments. As a result, it was revealed that the barrier well extracted highly concentrated saltwater when the pumping ratio was less than 1.9. This extraction of highly concentrated saltwater has a large positive effect to prevent saltwater intrusion. Therefore, it is concluded that saltwater intrusion can be prevented by the barrier well as long as the pumping ratio is well controlled so as not to exceed the critical pumping ratio.