Effects of Saline Groundwater Pumping for Mitigating Seawater Intrusion in Coastal Aquifers

Euntae Jung, Dept of Civil Engineering. Dong-A University, dkwkro123@nate.com
Namsik Park, Dept of Civil Engineering. Dong-A University, nspark@dau.ac.kr
Kwangwoo Cho, Korea Environment Institute, kwcho@kei.re.kr

Issue of Coastal Saltwater Intrusion

As groundwater usage is soaring, Some big problems, such as climate change and seawater intrusion in coastal areas, are faced with around the world. Some countries have already configured the seawater intrusion Research Council for a study to reduce seawater intrusion.
This silent disaster caused by seawater intrusion problem will not be taken lightly anymore.
In this study, using Negative Barrier confirmed seawater intrusion abatement efficiency.

"Saltwater intrusion is the biggest untold water story in the world today. It's a silent problem. It's easy to ignore politically but it can spoil the water source for future generations." **– Ron Duncan, interim general manager Soquel Creek Water District**

Article about Coastal Saltwater Intrusion

Here Comes the Sea: The Struggle to Keep the Ocean out of California's Coastal Aquifers

WEDNESDAY, 23 SEPTEMBER 2015 13:36

Farm districts preserve fresh groundwater with recycled wastewater

Photo © Brett Walton / Circle of Blue

The Watsonville, California, recycled water facility, completed in 2009, purifies wastewater from the city of Watsonville for use by farmers in the Pajaro Valley. Using recycled water instead of groundwater prevents the Pacific Ocean from spoiling coastal aquifers with salt. *Click image to enlarge.*

By Brett Walton
Circle of Blue

WATSONVILLE, California — Driving on the world-famous Route 1, just south of town, a traveler looking west across fields of strawberries can see the great silvery expanse of the Pacific Ocean.

The land is heavy with a harvest that will soon be trucked to grocery stores and fruit stands throughout the United States. The Pacific, in the late afternoon sun, dazzles like camera flashes. But the ocean also is stealthy. It creeps inland in less obvious, more destructive ways. Beneath the berry patch, a rising tide of salty water threatens one of the most lucrative and productive farm regions in the country. Coastal wells are slowly being poisoned with rising concentrations of chloride.

House forms committee to study saltwater intrusion into aquifers

By **Walter C. Jones** Thu, Mar 19, 2015 @ 5:15 pm

ATLANTA | The House will create a temporary committee to study ways to combat saltwater seeping into the aquifers that provide coastal residents their drinking water under legislation passed Thursday by the Natural Resources Committee.

Committee Chairwoman Lynn Smith sponsored House Resolution 601 along with Savannah-area legislators Ron Stephens, Jesse Petrea and Bob Bryant. Only Bryant is a Democrat.

Saltwater intrusion is a pesky problem, more prevalent on the South Carolina side of the Savannah River, but experts fear it will become a bigger concern along the Georgia coast soon.

At the same time, a subcommittee of Natural Resources hasn't yet scheduled a hearing on Senate Bill 36, a separate measure that would require the Natural Resources Board to approve regulations for protecting the Floridan Aquifer from contamination caused by the injection of surface water, a strategy South Carolina uses to create pressure that slows the saltwater intrusion.

The Deal administration and business groups have fought efforts by coastal lawmakers to prohibit aquifer injections out of fear that South Carolina will sue Georgia for not doing its share to keep the aquifer usable. Such a lawsuit could result in court-ordered reductions in aquifer Georgia withdrawals, limiting economic development.

Smith said she hasn't read the latest version of the Senate bill and isn't using her study proposal as a substitute for action on SB 36.

"This is something I've been working on for some time," said Smith, R-Newnan. "This is much, much broader."

The Georgia Chamber of Commerce supports the study, according to its lobbyist Doug Miell.

"Saltwater intrusion is already a real issue in parts of the coast of Georgia," he said. "With forecast population and business growth, there will be increasing demands for access to quality, reliable groundwater supply for the coastal economy."

The legislature conducted a similar study years ago, Smith said, but it's worth doing again because now there is a regional water plan, written by local leaders in 2011.

The committee conducting the study is to complete its recommendations before December and then disband.

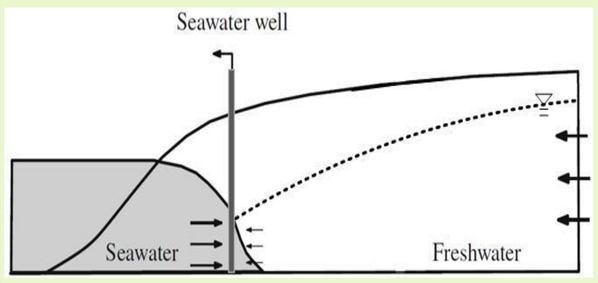
Walter Jones: (404) 589-8424

Methodology

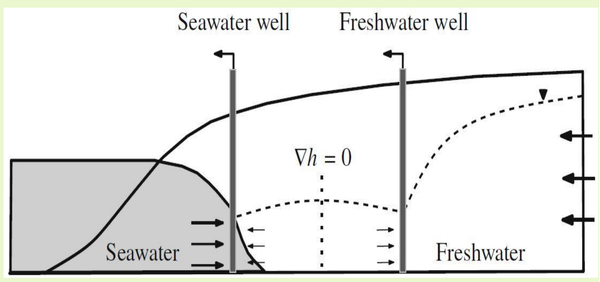
In this study, we investigated the Single negative barrier and Double negative barrier. Single negative barrier, located on the coastal area, is a method of pumping only seawater. Double negative barrier are separated by seawater negative barrier and freshwater negative barrier which is located on coastal area and inland, each of them produce seawater and freshwater respectively.
Both methods share the disadvantage of low energy efficiency. However, they are less costly than low permeability barriers or positive hydraulic barriers. One of optimization targets would be the maximization of saltwater ratio at a saltwater pumping well. In this work we determined saltwater intrusion length as a function of pumping well locations and pumping rates. In particular we tried to produce groundwater, which satisfies drinking water criterion on TDS (in Korea, less than 500mg/l), using the double negative barrier.

Type of Negative Barrier

- *Single Negative Barrier*



- *Double Negative Barrier*



Modeling Domain

We have used the sharp-interface approximation for modeling fresh and saline groundwater flows.

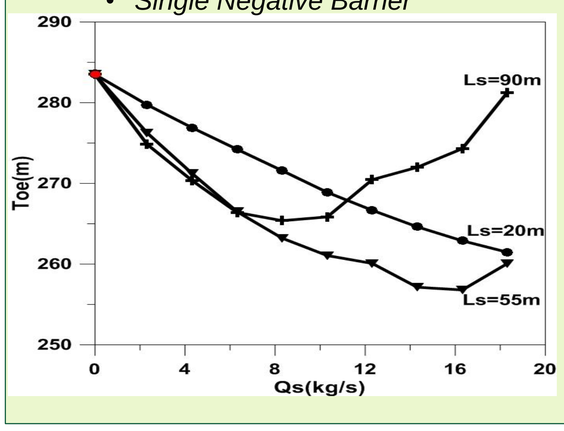
- The hypothetical model domain considered is 500m by 500 square. One side of the square is a coastline where sea water can intrude and freshwater can leave the aquifer. Two boundaries perpendicular to the coastline are assumed no flow boundaries. Along the inland boundary uniform fresh groundwater flux is specified. The influx sums to be 648m^3/d.
- The hydraulic conductivity of the aquifer is 10.6m/d, effective porosity is 0.3, freshwater density is 1000kg/m^3 and the specific gravity of sea water is 1.027.
- Single seawater pumping well at a distance of 20m, 55m, and 90m from the coast line is considered. Pumping rates applied are 0 and 1550m^3/d.
- For the double negative barrier, the freshwater well is fixed at 300m from the coast line. The freshwater-well pumping rate varies from 0 to 190m^3/d. The saltwater well location is chosen from 20m, 40m, 55m, 70m, and 90m. The pumping rate applied varies between 0 and 1550m^3/d.

Result

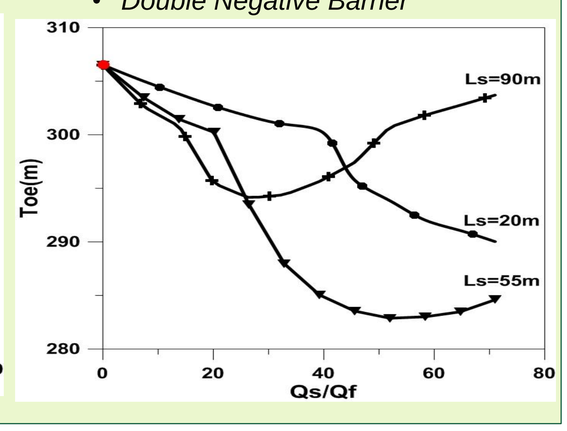
-Both type of barriers, single and double, can be used to mitigate saltwater intrusion in groundwater. Double negative barriers can reduce up to 10% of natural saltwater intrusion length.
-Double negative barriers performed less efficiently in mitigating saltwater intrusion. But the former offers the advantage of freshwater production in an inland well and of lowering groundwater level. Lower groundwater levels may benefit low lying coastal areas where groundwater logging is a chronic problem.
-Cases considered show that saltwater intrusion reaches a quasi-steady state after about twenty years.

Saltwater Intrusion Distance

- *Single Negative Barrier*



- *Double Negative Barrier*



Seawater ratios (%) of freshwater well (a)~(c), at 300 m, and of saltwater well (d)~(f). Saltwater well locations: (a) and (d) at 20 m, (b) and (e) at 55 m, and (c) and (f) at 90 m