Salinity in Outer Banks wells traced to fossil seawater

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Rising salinity in the primary source for desalinated tap water in North Carolina's Outer Banks has been traced to fossil seawater, not – as some have feared – to recent seawater intrusion.

This means the saline groundwater in the Yorktown aquifer can remain a valuable source of desalination for decades to come, without Dare County communities having to switch to the much more costly alternative of desalinating seawater, says Duke University researcher Avner Vengosh.

Vengosh, professor of geochemistry and water quality at Duke's Nicholas School of the Environment, recently directed a study to measure and analyze salinity levels in the Yorktown aquifer and identify their source. The study appears in the online version of *Hydrogeology Journal*, a peer-reviewed publication.

Salinity levels in the aquifer are roughly 2.5 times higher today than when the Dare County North Reverse Osmosis Water Plant in Kill Devil Hills began pumping and desalinating groundwater in the late 1980s. Some feared the rise was caused by seawater seeping into the aquifer. However, by using geochemical and boron isotope tracers, Vengosh's research team found that the increase is from an upflow of old and diluted seawater, trapped long ago in the Atlantic coastal aquifers.

And that can be viewed as good news, Vengosh explains.

"As more and more water is pumped out of the Yorktown aquifer to meet growing year-round demand, the groundwater level is dropping and the relative proportion of fossil seawater, flowing up from deeper aquifers, is increasing," he says. "As fossil seawater mixes with the remaining fresh groundwater, it is raising salinity, but at a relatively slow and steady rate that is more manageable and sustainable than the rapid increase we'd see if there was modern-day seawater intrusion."

Tests showed that the Dare County water plant's reverse osmosis membranes still remove about 96 to 99 percent of the dissolved salts from the aquifer's groundwater.

The membranes haven't remained as effective at removing boron and arsenic, which occur naturally in deep saline groundwater. Tests of the water plant's four wells found the membranes remove only between 16 percent to 42 percent of the boron in the water, and 54 percent to 75 percent of the arsenic. The arsenic levels – which are below safe drinking levels after additional treatment that follows the reverse osmosis desalination – aren't expected to rise in coming decades, but boron levels likely will, in relation to the aquifer's rising salinity.

"Boron isn't currently regulated as a drinking water contaminant in the United States, but there are international recommendations about safe levels for human consumption," Vengosh says. "Additional treatment might be needed to remove boron from the desalinated Dare County groundwater."

Even with the additional costs, desalinated groundwater remains a bargain compared to desalinating seawater, Vengosh says. Desalinating seawater requires substantial additional capital investments and advanced filtration technology, largely because of the quantity of salts that must be removed. Seawater contains about 35 parts per thousand of dissolved salt. The groundwater currently used by Dare County has a dissolved salt content of about 5 parts per thousand.

"Given a choice, groundwater desalination is the way to go, as long as you take care of other contaminants, such as arsenic," Vengosh says.

The new study is the first to directly link fossil seawater to rising salinity in a groundwater aquifer. "The coastal aquifers in the southeastern U.S. contain a large volume of brackish water that could sustainably be used for desalination or any other applications that can tolerate their relatively low salinity, particularly as other water sources are at risks due to climatic change and human stress," he says. "Because of this, the implications of this study may extend far beyond the Outer Banks."

Provided by Duke University