

# Researcher probes saltwater intrusion into Calif.'s coastal groundwater supplies

**Debra Kahn, Environment & Energy Publishing, 10-23-14**

MONTEREY, Calif. -- Here, in one of the most picturesque parts of California's long Pacific Coast, researchers are investigating what could be a large and contentious unknown: the groundwater that lies beneath the shoreline.

A Stanford University earth sciences professor, Rosemary Knight, is investigating the extent to which salt water has intruded into underground aquifers. The topic is of immediate relevance in the drought-stricken state, and particularly along the 24-mile stretch Knight has selected where small legal wars over groundwater use are brewing.

Using wells to pump out the fresh groundwater has been drawing salt water into aquifers for decades. Against the background of the record-breaking drought, the questions are: How serious could the saltwater intrusion become, and how it will affect supplies of fresh water to residents, businesses and agricultural uses?

Knight's technique, called electrical resistivity tomography, reveals the composition of underground water, clay and other substances. She draws a comparison to medical techniques like magnetic resonance imaging that can see soft tissue in the human body.

ERT can perform a similar function underground, she said, exploring the underground geography and supplementing data from monitoring wells. The wells are expensive to dig and can only gauge the quality of the water located directly underneath them.

That's not enough to know how severe the problem has become. "Would you ever go in for exploratory surgery anymore?" she asked. "No!"

For a two-week period earlier this month, Knight and her research and engineering team were busy laying out electrical cables across 1,800-meter stretches of sand at a time. The cables are punctuated by 4-foot steel poles sunk into the sand every 22.5 meters.

Using oil exploration techniques

The poles send electrical current into the sand and measure the electrical potential to determine the electrical resistivity of the ground. Since salt water is a good electrical conductor, it shows up as a region with much lower resistivity than slightly salty or clean groundwater.

The data yield an image of a two-dimensional slice of coastline, up to 300 meters (984 feet) deep. Then the research team on the beach packs up the poles and moves on to the next stretch of beach, covering a little more than 2 miles of shoreline each day.

The technique is commonly used to explore for petroleum in Canada's oil sands but is just starting to be applied to groundwater analysis. An initial pilot study of a 4-mile stretch from Marina to Seaside, Calif., found that deeper groundwater deposits in the southern part of the study were protected from the salt water in an overlying aquifer by a clay barrier, but that the barrier was absent to the north, making the groundwater there susceptible to leakage from above.

"The groundwater managers to the south shouldn't just be looking to the sea for potential saltwater intrusion," Knight said. "They should be looking to the north."

The data could come in very handy on the central California coast, which is divided into a patchwork of water suppliers, water agencies and water sources. Groundwater provides about 40 percent of the fresh water used in the United States. It constitutes 99 percent of Monterey County's supply. Monterey County is not connected to the system of canals that supply other areas of the state with water from the Colorado, Sacramento or San Joaquin rivers, or the pipelines that provide water from the Sierra to the Bay Area and Los Angeles.

The city of Marina (pop. 29,000), just north of the Monterey Peninsula, is currently sparring with California-American Water Co. over a proposed well's effects on groundwater supplies.

Cal-Am -- a subsidiary of American Water, which is the largest investor-owned water provider in the country -- hopes to drill into a heavily saltwater-intruded aquifer that is above the one that supplies the entire city of Marina and the majority of Fort Ord, a former Army base that is currently being redeveloped.

Saltwater intrusion has been a problem in the area for decades. In 1983, Marina's water district had to abandon an aquifer 180 feet underground due to saltwater incursions. From 1983 to 1989, the water district drilled three wells into another aquifer located beneath it, 900 feet below ground.

A county, cities and the state get involved

In 1997, Marina's water district also completed a desalination plant, but electricity prices are high enough that it's not economical to use when there is still groundwater to tap.

Now, Cal-Am is proposing to drill a slant well from the shore into the 180-foot aquifer to see if the water is suitable for using in a new desalination plant, to benefit the towns of Carmel, Monterey, Pacific Grove and Seaside, and other areas of the peninsula.

Cal-Am is facing an order from the State Water Resources Control Board to stop drawing from the Carmel River -- which supplies 70 percent of its water -- by 2017. The test well is intended to "improve the precision of groundwater modeling" in order to determine whether and how much of the desalination water would be drawn from inland sources.

The Marina City Council voted last month to deny a coastal development permit and require an environmental impact report for the slant well, arguing that the well would likely not be decommissioned after its exploratory use and should be considered as part of Cal-Am's larger

desalination plans. The council also cited objections raised by the Marina Coast Water District that the well could increase saltwater intrusion.

A local land-use lawyer with experience in water issues said Knight's technique could be ideally suited to the question of the test well's effects.

"It's a perfect example of how science can clarify what is happening under the ground, instead of arguing about it on top of the ground without the science," said Molly Erickson, a lawyer and former board member of the Monterey Peninsula Water Management District. Her firm, Stamp Erickson, represents agricultural interests, environmental groups and others on land and water issues.

"If I were Marina Coast [Water District], I would want to be darned sure that Cal-Am pumping from the test well or any well does not introduce or has the potential to contaminate the small deep aquifer with saltwater intrusion," she said. "If the deep aquifer turns salty, Marina would lose its water supply, and Fort Ord would lose its water supply. That is very serious business."

A spokeswoman for Cal-Am said she hadn't heard of Knight's study yet.

New legislation signed last month by Gov. Jerry Brown (D) is also placing statewide restrictions, for the first time, on the pumping of groundwater. The law gives the state the power to step in and regulate groundwater if local managers don't address a host of issues, including degraded water quality, chronic groundwater depletion, land subsidence and saltwater intrusion.

#### Unexplored territory

The measurements could help local officials comply with the law, Knight said. "It's very hard to plan if you don't have sufficient information about the current state of your groundwater resources," she said.

Rob Johnson, assistant general manager of the Monterey County Water Resources Agency, said it is too early to tell if the method might prove useful. His agency monitors seawater intrusion by sampling about 90 wells several times per year. It produces maps every other year from the previous year's data; a new map, with 2013 data, is due out next month.

"I think it's only going to be valuable to the areas where they think they may not have seawater intrusion," he said. "Where we already know that it's occurring, I don't know that this provides much help."

The initial research is being done for about \$150,000 of engineering work by the firm WorleyParsons; follow-up monitoring should cost about \$3,700 per kilometer, Knight said.

"It comes down to: What is the value of this information?" she said. "Or what is the cost of not having it?"

Another Stanford professor, an expert on groundwater management policy, said Knight's work would give local officials "another dimension of information that is critical."

"Historically, we haven't treated groundwater like the valuable resource it really is," said Buzz Thompson, co-director of the Stanford Woods Institute for the Environment and a natural resources law professor.

"What's happening now is we're waking up to the value of groundwater and therefore the importance of managing it properly. Once you do that, you begin saying to yourself, 'Yeah, we should take that technology that the oil industry has used, and we should use it in water, because water is just as critical of a resource for us.'"

Monterey area managers have a good sense of how far salt water has intruded, he said, and possibly how fast it is moving, but they don't know enough about wells that are still fresh but could be pulling salt water toward them.

"You need a good sense of that in order to know how you're going to manage the aquifer," he said.

None of this has been easy. Knight said that to lay cables across the 24 miles of coastline, her staff had to get permission from about 40 landowners. Some did not agree, so the survey will be broken in three places.

"Had we known in advance the amount of work this was going to be with the permitting, we probably wouldn't have done it," she said. "I'm glad we didn't know."