# UCI scientists use near real-time sensor data to detect coastal ocean pollution

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A discovery by UC Irvine scientists could help public health officials know instantly when pollution has moved into the coastal ocean -- a breakthrough that could enable authorities to post warnings or close beaches in minutes rather than days.

The new technique analyzes temperature and salinity data collected by sensors located in the water along the Southern California coast. Researchers found that fluctuations in the sensor data correlate with changes in water quality as soon as they occur. This type of analysis may lead to detection methods that are far faster than the current method of physically collecting water and testing it in a lab.

"Decisions to post a warning or close a beach are currently made one to three days after a sample is collected. This would be fine if you were testing water that sits in a tub, but ocean currents are highly dynamic, and water quality varies hour by hour and minute to minute," said Stanley B. Grant, professor of chemical engineering and materials science at UCI. "Our research shows that near real-time sensor data can be used to detect changes in the state of the coastal ocean -- information that could, in concert with traditional monitoring data and new ocean observing systems, eventually result in the creation of an up-to-the-minute water-quality report accessible by the public on the Internet."

Grant, along with Brett F. Sanders, associate professor of civil and environmental engineering, and graduate student Youngsul Jeong published their research in the current online issue of Environmental

Science and Technology.

Coastal ocean observing systems -- devices that use technology to sense environmental conditions -- collect large amounts of data such as temperature, salinity and water level. The data is streamed in near real-time via the Internet for scientists and coastal managers to process and interpret.

These sensors cannot measure bacteria levels that officials use to determine whether surf-zone water is safe for bathing, but UCI researchers discovered that changes in temperature and salinity can signal pollution if the data -- using a mathematical equation -- is transformed into a measurement of the range over which the data naturally fluctuates. This study shows for the first time that two measures of these fluctuations -- Fisher Information and Shannon Entropy -- can translate high-frequency sensor data into information suitable for near real-time management of the coastal ocean. Fisher Information and Shannon Entropy have been used in other cases to detect abnormalities in brain signals.

"At Newport and Huntington beaches -- where we tested the idea -- water quality violations were more likely to occur when, over the course of a single day, salinity fluctuated around a larger range of values and temperature fluctuated around a more narrow range of values," Grant said. "These patterns of fluctuation reflect the mixing of different parcels of water -- some contaminated and some not -- into the coastal ocean."

The research team analyzed data recorded over three months in early 2004 by a sensor located one meter underneath the water at Newport Pier. The sensor is part of a growing network of coastal sensors called the Southern California Coastal Ocean Observing System. During the period of data collection, local officials noted 35 days in which one or

more water quality standards were violated at nearby Newport and Huntington beaches. Researchers then conducted a mathematical study to asses how water quality correlated with the daily average sensor measurements of salinity and temperature, and with the Fisher Information and Shannon Entropy calculated from this data.

Scientists found that water quality coincided with depressions in ocean salinity, but not with changes in near-shore ocean temperature. However, when the sensor data was transformed using Fisher Information and Shannon Entropy, surf zone water quality violations correlated with a number of resulting indices, most notably salinity and temperature. This indicates that changes in the range over which salinity and temperature fluctuate -- measured by both Fisher Information and Shannon Entropy -- appear to reflect the origin, transport and mixing of pollutants in the coastal ocean.

"If we could use this knowledge to build a next-generation pollution warning system, bathers could know quicker when pollution moves into the surf zone," Grant said. "The economic and personal benefits would be enormous. The public could go to the ocean and have fun and not get sick the next day."

Bathing in polluted ocean water can cause gastrointestinal disease, diarrhea, vomiting, and eye and ear infections.

Source: University of California - Irvine