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The Color of Disease [1]

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Scientists may one day use satellite information to halt the spread of infectious diseases.

Four thousand people lost their lives during 1991, the first year of the Peruvian cholera epidemic. Before 1992 was spent, the disease had claimed another thousand victims and the villain, Vibrio Cholerae 01, was beginning to move inland and up the coasts of Latin America and the United States, taking lives in virtually every country. Between 1991 and 1992, in excess of 700 thousand cholera cases in South, Central and North America had been reported to the Pan American Health Organization (see Centers for Disease Control. 1993. Morbidity and Mortality Weekly Report 42(5)). The disease, characterized by vomiting and diarrhea, results in an exhausting dehydration. In Peru alone, its drain on human productivity, added to seafood export- and tourism-dollar losses cost the country in excess of a billion dollars, according to one expert.

"These health costs ripple through economies," said Dr. Paul Epstein, Associate Director for the Center for Health and the Global Environment (CHGE) at the Harvard Medical School. Peru's loss to the recent cholera epidemic is only one example of the price paid around the world to such infectious vector-borne diseases (VBDs) as malaria, encephalitis, and dengue fever. Epstein maintains that these killers can quickly exact staggering tolls on nations' development, trade, tourism, and agriculture.

With rapid identification of risk factors, public health officials can institute remedial measures to contain disease waves and save lives. Epstein and colleagues at the CHGE are using information from satellites to help identify and track infectious diseases spreading across oceans and land. Aimed at developing disease early-warning and prevention systems, Epstein's work is also connecting the spread of infectious diseases worldwide to changing environmental and climate conditions in marine and terrestrial ecosystems.

Satellite imagery and classical water sampling indicate that harmful algal blooms (HABs) appear to be increasing in intensity, duration and extent, Epstein says. HABs can impact health issues in direct and indirect ways, he explained. "Brown tides" generally refers to the suffocation of sea grasses by algae, which affects shellfish populations and other dependent life forms, like birds. Some brown tides are also directly poisonous. "Red tides" poison fish and shellfish, presenting potentially toxic hazards for human beings. And, algal blooms can harbor bacteria that infiltrate the food chain, water supplies, and human populations through the marine environment.

An association between seasonal coastal algal blooms and cholera outbreaks has been established since the 1960s, Epstein said. Of plankton species, both algae and zooplankton are known to harbor bacteria, and cholera is linked specifically to zooplankton. Using satellites, no method to distinguish zooplankton from surrounding species yet exists. But, with an established relationship between algae and zooplankton abundances, satellite data could be key.

"We're hoping to use color imaging data from the Coastal Zone Color Scanner (CZCS) and subsequently, data from instruments of similar capabilities for a cholera early warning system as well as for red tide alerts," Epstein said. "If public health measures are taken early they can prevent the kind of thing that happened in Latin America in 1991, where 5,000 deaths occurred in the first 18 months. There was no awareness of the way (the cholera infection) was coming in from the coast," he said. Shellfish monitoring, alerting populations to the need for boiling water, and preparing for treatment by establishing oral rehydration centers could all be undertaken with timely knowledge of a pending threat.

But the bigger picture in ocean color is that the increase of HABs, and disease patterns associated with them, may accompany climate changes and destruction of regional ecosystems, Epstein said.

In spite of strong correlations, the evidence linking ocean color to cholera outbreaks is still experimental, Epstein says. But, pointing to a project at Woods Hole, Massachussetts that has successfully used satellite imagery to target sampling of spring blooms, with an early-warning system geared toward stemming paralytic shellfish poisoning, Epstein said, "We're convinced enough. We would like to do experiments real time.

"There's no question about red tide issues, and now everything is pointing to the cholera stories, so increasing sampling of plankton blooms on the basis of remote sensing -- there's no question that could be of value."

Resource(s)

The CZCS was the first instrument devoted to ocean color measurement flown on a spacecraft. Although other instruments could sense ocean color, their spectral bands, spatial resolutions and dynamic ranges were optimized for land or meteorological use and had limited sensitivity over water. The CZCS was optimized for use over water. It works on the principle that water content, organic or inorganic particulate matter or dissolved substances, affects its color. For most regions of the world, ocean color is determined primarily by the abundance of phytoplankton present. As the concentration of phytoplankton pigments increases, ocean color shifts from blue to green. Inorganic particulate matter in water, such as river outflow, has different colors than organic material.

CZCS data are available from the Goddard Space Flight Center DAAC, which will also archive and distribute follow-on ocean color data sets derived from the Japanese Ocean Color and Temperature Scanner (OCTS), Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and the Moderate Resolution Imaging Spectroradiometer (MODIS).

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