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# AEROSPACE AMERICA


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# Earth observations lead to healthier lives

*Bloom of the toxicalga Karenia brevis is visible along the west coast of Florida. Image from Jacques Descloitres; NASA.*

***Factors such as air pollution, flooding, and changes in rainfall patterns can cause or aggravate conditions ranging from asthma to heart disease to malaria. Data from Earth observations aid public health decision-makers by alerting them to environmental changes, so they may plan more effectively for coping with health implications.***

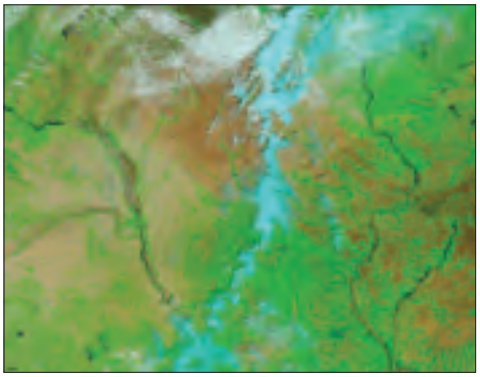
## Earth observations enable us

to monitor and anticipate key environmental phenomena that affect our health. The data they provide can be incorporated into models to help detect, monitor, or predict disease, giving policy-makers the opportunity to control an epidemic, respond more quickly to disease outbreak, and act to prevent or mitigate the occurrence of disease. Air quality, water quantity and quality, infectious disease, waterborne and insect disease vectors, and temperature are areas where Earth observations can most readily benefit public health.

For example, combined space- and ground-based measurements help local and national policy-makers reach better decisions on controlling emissions that can cause or exacerbate cardiovascular and respiratory diseases. Earth observation measurements of rainfall and remote sensing of oceans, lakes, reservoirs, and aquifers are critical to decision-makers for planning and adapting to changes in rainfall patterns that cause droughts, floods, and water contamination, posing significant health risks. Changes in land cover and habitat, for example, can help identify disease vectors and predict infectious diseases.

The public health benefits of such data have gained increasing recognition over the past decade. The Intergovernmental Group on Earth Observations, or GEO (comprising more than 85 nations and the European Commission) and the U.S. Group on Earth Observations (USGEO, with representatives from more than 15 federal agencies and the White House) have focused on the acquisition and use of Earth observation data to achieve societal benefits including improved health. These groups have taken actions to provide public health officials with such data, and the tools for using it, working with them to apply the knowledge to their objectives and needs.

Several U.S. government Earth observation and public health organizations are also working in this area and cooperating in science and operational coalitions. These groups include NASA, NOAA, the U.S. Geological Survey (USGS), the Centers for Disease Control and Prevention (CDC), the EPA, the National Institutes of Health (NIH), DOD Armed Forces Health Surveillance Center, and the U.S. Agency for International Development (USAID).



*The summer of 2011 brought flooding along the Missouri River. Captured by the Moderate Resolution Imaging Spectroradiometer on NASA's Terra satellite, these images show the advance of flood waters on the river between May 30 and June 27, 2011. A combination of visible and infrared light increases contrast between water and land.*

### Earth observation provider activities

Over the past decade, the NASA Public Health program has been developing tools to support planning, management, and policy decision-making for the public health, medical, and environmental health sectors. NASA partners with national, state, and local public health agencies on a wide range of projects using Earth science research for public health. The projects address epidemiological surveillance in the areas of infectious disease, environmental health, and emergency response and preparedness.

For example, the NASA-funded Environmental Health Application System project has been working with the New Mexico

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*Western Lake Erie algae blooms can be seen with the naked eye.*

Dept. of Health using remote sensing data and models to improve forecasts of atmospheric ozone, fine particulates, and other aerosols that trigger asthmatic responses or heart attacks. Daily dust forecasts now are available on the department's website and transmitted to local officials. Using these forecasts, hospitals can adjust staffing levels for episodic increases in patient numbers, schools can keep students indoors at recess, and parents can ensure that children use needed medications.

NASA also worked with public health officials in California using remote sensing data and models to determine risks of mosquito outbreaks. This improved the state's ability to align intervention and response strategies with risks, and to initiate mosquito population control methods when necessary. NASA requires the involvement of the public health community in its projects, seeking their input on topics for investigations that help shape the content of future project solicitations.

NOAA initiated an Oceans and Human Health Initiative to bring together relevant experts from across the agency, in partnership with academia, the private sector, and other federal, state, and local agencies. While this is a fairly new initiative, it has already elevated the importance of health within NOAA. Related agency efforts flow from its long-standing role in health as it relates to climate, oceans, and marine animals, and its role in weather and climate data acquisition, modeling, and forecasting.

*Harmful algal blooms are an accumulation of tiny organisms known as algae and can release harmful toxins into the environment. Binder Lake in Iowa is seen here covered in algal blooms. Among other effects, such blooms can cause fish kills in areas where oxygen is depleted or when algal blooms are producing toxins. Photo by Jennifer L. Graham, U.S. Geological Survey.*

For example, the National Weather Service provides forecasts for CDC researchers studying the effects of heat waves and also works with state and local officials to prevent heat-related morbidity and mortality. NOAA is funding forecasting tool studies, including one that involves incorporating a climate element for forecasting algae blooms in the Great Lakes. The agency is also funding development of a pathogen model as a tool for managers of drinking water treatment plants and beaches; a sea surface temperature tool for early warning of cholera and other bacteria; and tools for forecasting the impacts of coastal development on the ecosystem and public health.

USGS works with the health community to examine the connections between natural science and public health. The agency synthesizes scientific information on natural and living resources that influence human health and presents the material in a useful format. For example, USGS scientists used Landsat imagery in studying West Nile virus prevalence and land cover variation. The results suggested that preserving large wetland areas and, by extension, intact wetland bird communities, may be a valuable ecosystem-based approach for controlling West Nile virus outbreaks.

USGS also provides, at no charge, all of its archived Landsat scenes and has partnered with the private sector to create a new geospatial website, "Change Matters." This website enables scientists and the public to see more quickly how landscapes have changed over time as a result of forest harvesting, urban growth, wildfires, floods, pest outbreaks, and drought.

### Public health community efforts

CDC has partnered with NASA since 2004 to investigate how NASA Earth science can help to determine the link between the environment and health. The two organizations are studying how remote sensing data can fill gaps in environmental data collected on the ground to understand the incidence of asthma and to link environmental and cardiovascular health data.

The CDC Climate Change Program is also working with NASA to develop decision-support tools. One project uses Earth observation data and models to improve

heat watch warning systems, incorporating meteorological, mortality, remotely sensed, and sociodemographic data. CDC is initiating a similar project using remote sensing to aid in identifying locations that are particularly vulnerable to flash flooding and to enable more effective mitigation of its health-related impacts.

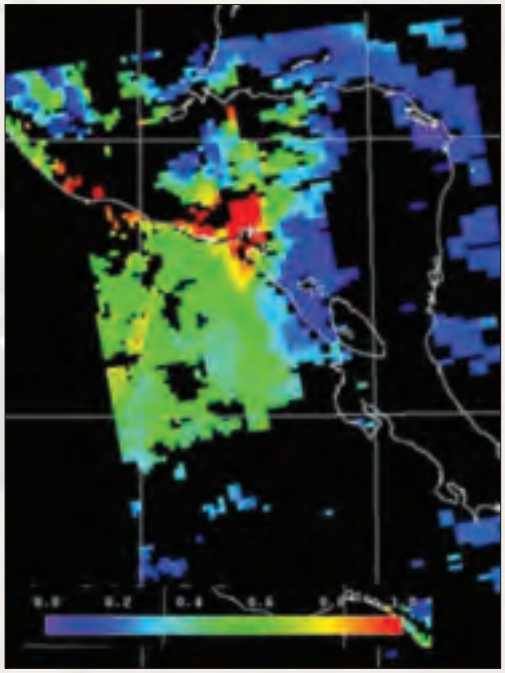
In addition, CDC is working with NASA to develop a climate model that integrates observed ground weather station data with modeled data and also takes land surface data into consideration. Last December, CDC included the model in its Environmental Public Health Tracking Network, undertaken to identify and track environmentally caused health problems in the U.S. For the network, NASA is providing CDC with remotely sensed observations and products, and NOAA is working with CDC to support integration of ocean, climate, and public health information.

The EPA established its Advanced Monitoring Initiative (AMI) to bring environmental information to decision-makers and has provided seed money for more than 100 projects. AMI has integrated remotely sensed and in-situ data to form new models for air quality forecasting, nitrogen deposition, harmful algal blooms, and Lyme disease risk maps. For example, the AIRNow program partnered with NOAA, NASA, the National Park Service, and state and local environmental and health agencies to develop a website that provides daily air quality index conditions and forecasts.

Another AMI project used remote sensing data to develop a tool for evaluating in-situ data on nitrogen emissions. The tool detected a discrepancy between the numbers recorded in the National Emission Inventory (NEI) and the predicted emissions based on the $NO_2$ column. EPA's investigation found that a transcription error had occurred when the numbers reported by the states were entered into the NEI, and the error was corrected. The agency is also applying this tool to quantify emissions that are difficult to measure, such as exhaust from automobiles located in regions that lack a monitoring infrastructure. In addition, AMI projects have advanced the technology for forecasting beach and coastal health hazards by developing detection and warning systems for harmful algal blooms, bacteria outbreaks, and coastal flooding. All AMI projects strive to involve the final stakeholders early in the project to ensure that the products are relevant and useful.

The NIH's National Institute of Environmental Health Sciences works with other federal agencies, international research and policy groups, academia, and nongovernmental organizations to identify gaps in knowledge about the links between climate change and adverse human health impacts. Together these groups are also developing a research plan to address these gaps, communicate findings, and incorporate them into health policy and actions.

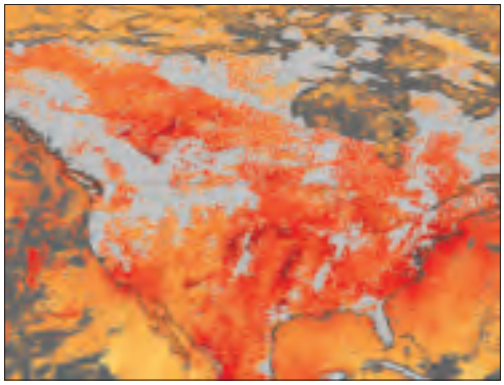
Another NIH effort, the Human Health Impacts of Climate Change program, funds research in this area as well. Working with NASA, EPA, and other agencies, the program seeks to fill in data gaps, develop an inventory of relevant databases, and identify what is needed to enhance the agencies' capabilities. NIH recently launched a multiyear study to look at the potential health effects of the 2010 oil spill in the Gulf of Mexico region. In planning the study, it used remote sensing data for some of its exposure scenarios and exposure modeling. The researchers plan to make greater use of remote sensing data as they become available for this study.



*An Aerosol Optical Depth image of fires in Nicaragua and Honduras was provided by the MODIS sensor on NASA's Aqua satellite on April 27, 2008. The red areas indicate that the satellite detected high concentrations of particles in the vertical column of air between the satellite and the ground, likely due to smoke from the fires.*

The Armed Forces Health Surveillance Center collects and interprets data that impact the health of U.S. military populations. In Southeast Asia where U.S. troops are deployed, it uses NASA Earth observation data for tracking malaria conditions to determine appropriate preventive measures. Among its key projects is the Global Emerging Infections Surveillance and Response System, which focuses on national and international preparedness for infectious disease outbreaks. A model using monthly reports and risk maps developed from satellite vegetation measurements and climate data provided by NASA successfully predicted an outbreak of Rift Valley fever in 2006-2007 and again in 2010. It provided warnings two to six weeks in advance, enabling health authorities to inform the public, control mosquitoes, and vaccinate livestock.

USAID has worked with NASA since 2003 in establishing centers that enable



*More of the U.S. was in a drought in July 2011 than in any other month in the past 12 years, according to the National Climatic Data Center; 26% of the lower 48 states experienced severe to extreme drought. Credit: NASA Earth Observatory image created by Jesse Allen using data provided by the Dept. of Agriculture Foreign Agriculture Service and processed by Jennifer Small and Assaf Anyamba.*

people in developing regions to use Earth observations for addressing challenges in agriculture, energy, health, biodiversity conservation, climate change, disaster response, and weather forecasting. The SERVIR initiative integrates satellite observations, ground-based data, and forecast models to monitor and predict environmental changes and improve decision-making in these areas. Regional SERVIR hubs are located in Panama, Kenya, and Nepal.

While these efforts are bringing about tangible benefits for public health, they are just a beginning. Funding in this area has remained very low for the past several years because of competing priorities. Far greater benefits also would result if a broader segment of the public health community could be engaged in developing the tools it will need to confront pressing health issues.

## Future needs

Further benefits to public health would result from improvements in several areas. These include expansion and enhancement of remote sensing capabilities; continuity of Earth observation data and research; integration and interoperability of satellite, in-situ, health, and socioeconomic data; more funding for developing and applying models and decision-support tools to analyze and apply the data; and enhanced dialogue between the Earth observation and public health communities on the potential health applications of Earth observation data and decision-support tools.

A September 2011 CSIS report, *Using Earth Observation Data to Improve Health in the United States,* identified several steps that should be taken to achieve these improvements and fully deliver on the potential of Earth observations for public health:

•The U.S. should increase its investment and pursue opportunities for international cooperation to enhance and sustain Earth observations, both from space and in situ, that would benefit public health as outlined by the NRC and USGEO.

•Support should be increased for federal Earth observation health application activities that engage the public health community in developing and/or improving models and decision-support tools.

•Support should be provided and prioritized for consortia of Earth observation producers and public health agencies to issue collaborative solicitations for further maturing applications, making mature ones operational, and initiating new ones.

•Engagement of the public health community should be broadened by holding a series of workshops on specific health topics to engage Earth observation providers and the public health community in dialogue on what Earth observation data are available; how they can contribute to detecting, monitoring, and predicting disease; and the models and decision-support tools needed to translate the data into information useful to the public health community.

• U.S. government support of the Intergovernmental GEO and of federal agencies' participation in GEO health tasks should continue, and the GEO's efforts to engage the public health community should be strengthened.

•Participating GEO nations should be encouraged to share public health data.

•The private sector should be engaged as an active participant in applying Earth observations to public health.

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The continued availability of Earth observation data undergirds the success of current efforts to translate the data into societal benefits. These data are helping the public health community understand the connections between the environment and health and act to prevent disease and mitigate its impacts. However, there are no plans to sustain the specific Earth observation capabilities now in place, and uncertainty in the budget outlook for the next several years complicates prospects for addressing the problem.

The U.S., while confronting its fiscal challenges, would do well to place priority on its ability to gather environmental data continuously over the long term and apply it to public health and other societal needs. U.S. efforts to meet this objective should be global as well as national. People will be healthier for it—as will the economy.