National Aeronautics and Space Administration
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EYES ON THE COASTS

As recently as March 1, 2002, high concentrations of Karenia brevis were located along the Lee County and Collier County shorelines in southwest Florida. In-water measurements revealed there were more than 1 million cells of the algae per liter of water—a level at which the organism became highly toxic to fish and shellfish in the area. This true-color image was acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS), flying aboard NASA's Terra satellite, on February 17, 2002. *(Image courtesy Jacques Descloitres, MODIS Land Rapid Response Team at NASA GSFC)*

NASA is collecting information of relevance to coastal management. Numerous missions are flying now, with more planned for the future, which provide valuable data relating to studies of sea level rise, hypoxia, harmful algae blooms and other related issues.

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Overview of the Program

At present, an array of Earth observing satellites are in orbit, and additional launches both by NASA and others will continue throughout the next decade. Our ability to observe our home planet from space has never been greater and will continue to grow. Increasingly, studies of the Earth focus on understanding the Earth's land, atmosphere, oceans, and various forms of life as a single integrated system rather than as individual independent elements. NASA is an important contributor in this systems approach to Earth Science studies.

Scientists at NASA work in partnership with other government, academic, private, and international organizations to identify ways to link Earth Science information to practical uses for society. Some of these partners contribute *decision support systems (DSS)* that help non-traditional users of Earth Science data use the information to make important decisions concerning environmental issues. The goal is to make sure Earth science data and information flows smoothly *from satellite to society*, so that the maximum number of people possible benefit from Earth Science information.

Coastal Management

Our Earth's coastal regions are a precious natural resource. The United States has over 95,000 miles of shoreline that provide resources for humans; homes for birds, animals and vegetation; and serves as vital ecosystems for many marine species. These shorelines are under siege from a number of natural phenomena. Global warming threatens to raise the level of the oceans and inundate our coastal lands. *Harmful algal blooms (HAB)*, sometimes referred to as Red Tide, are caused by explosive growth of certain rare toxic species of algae, in response to excess nutrients in the water. These algae form the base of the food chain, and thus threaten fish, shellfish, birds, marine mammals, and even humans. The incidence of HAB outbreaks has increased significantly in recent years. *Hypoxia* refers to low dissolved oxygen concentrations on the ocean bottom that occur when excess nutrients in the water lead to elevated algae concentrations that deprive the plants and animals that dwell in deeper waters of vital life-giving oxygen. Over 7000 square miles of the Gulf of Mexico are hypoxic—the largest swath in the Western Hemisphere. The health of our shores has a major impact on our nations socioeconomic well being, as more than half of our population live in counties that border the sea.

In order to gain a better understanding of the evolution of these harmful phenomena and better predict their occurrence, decision makers need accurate and timely information about the water in which they originate. Currently, coastal managers get very little warning about the onset of these harmful phenomena and thus it is difficult to offer advanced warnings. Even the warnings that are issued are not always accurate; false positive warnings of HABs—closing a beach or shellfish bed when hazardous conditions fail to materialize—are not uncommon.

NASA is an excellent source of information for coastal management studies. Part of the Earth Science Enterprise's research strategy addresses issues directly relevant to coastal management. NASA works with a number of Federal partners including the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA) and the Office of Naval Research (ONR), to understand the consequences of climate change, sea level change, and increased human activities on coastal regions. The partners seek to better understand how coastal ecosystems change over time and how these ecosystems respond to and affect global environmental change and the carbon cycle.

NASA has a long heritage of providing data for ocean research. This legacy began in 1978 with the launch of the Coastal Zone Color Scanner (CZCS) and the Advanced Very High Resolution Radiometer (AVHRR) onboard NOAA satellites. It continues to this day with the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), and with Earth Observing System (EOS) missions such as Terra and Aqua, which both have a Moderate Resolution Imaging Spectroradiometer (MODIS) onboard. Numerous other missions provide additional important information for coastal management issues, including TOPEX/Poseidon, Jason-1, the Gravity Recovery and Climate Experiment (GRACE), the Ice, Clouds and land Elevation Satellite (ICESat), and the SeaWinds instrument on both QuikScat and ADEOS II. The succession of NASA missions over the past 25 years has allowed it to establish a nearly-continuous data record for a number of critical variables in forecasting coastal phenomena, including sea surface temperature, sea surface height, sea surface winds, and chlorophyll concentration. These data records will continue in the coming decade as additional missions launch including the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), a partnership between NASA, NOAA and the Department of Defense, scheduled for launch in late 2006.

However, the story doesn't end with the collection of the data. NOAA provides a DSS into which data collected by these NASA missions can be input. This DSS is used to predict all aspects of outbreaks of HAB and hypoxia: their initiation, transport, toxic severity, landfall, and demise. Over the next 10 years, as more and more detailed information is available as input to the DSS, the simulations produced will become more and more realistic, leading to forecasts with increased accuracy and longer lead times. Currently, forecasts of landfall for HAB and hypoxia events can only be given about a day in advance; by 2010, it should be possible to predict landfall three to four days in advance, a major advance for coastal management decision making.

NASA's Earth Science Enterprise is international in scope with participation by the U.S., the European Space Agency, France, Canada, Japan, Russia, Brazil, The Netherlands, and Finland. The ESE works collaboratively with national and international scientists as well as Federal partners to provide quality science observations and predictions as input into coastal management models. NASA is committed to expanding the use of Earth Science results to serve as decision support tools for the benefit of society.

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