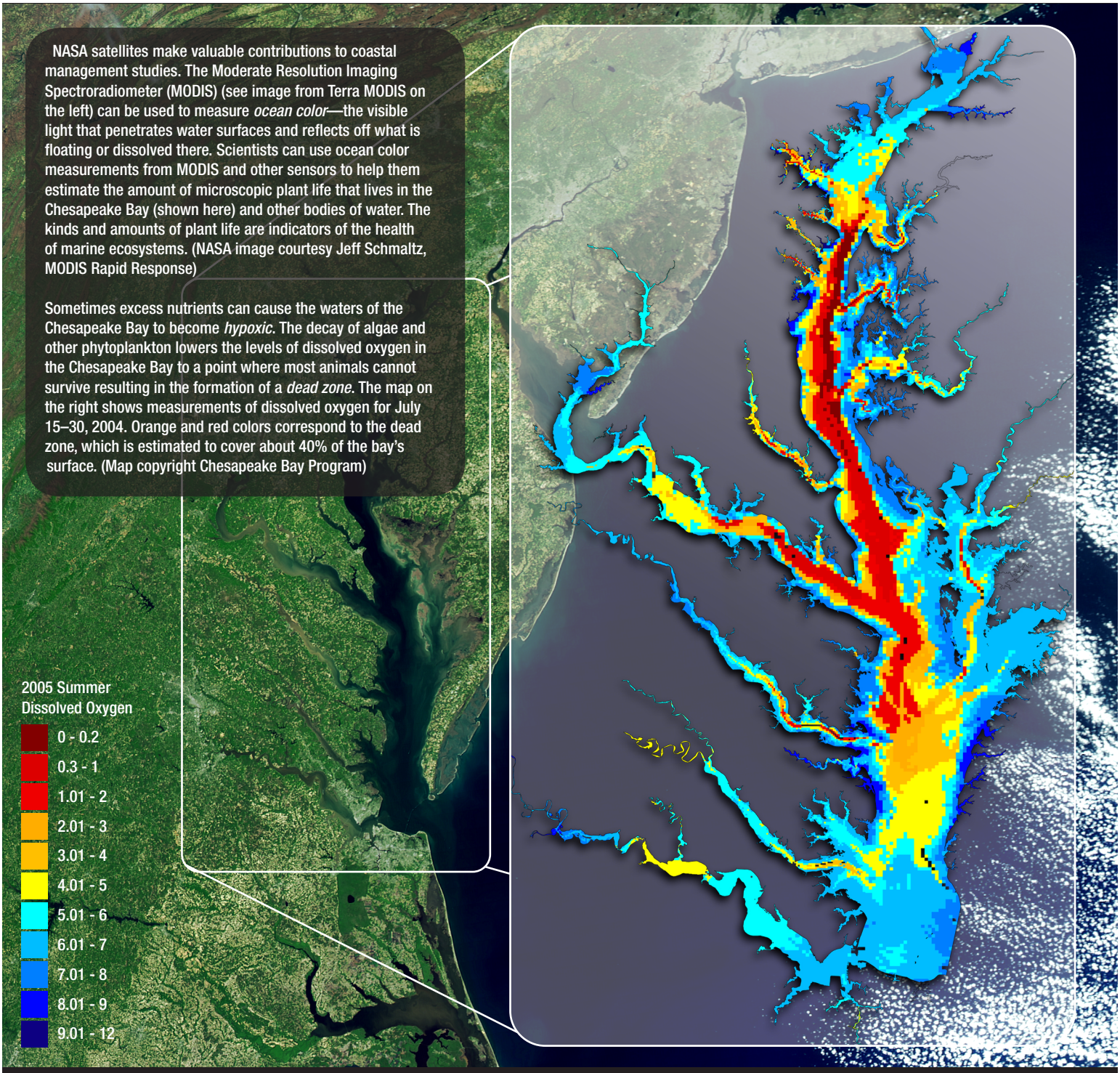
National Aeronautics and Space Administration

SCIENCE SERVING SOCIETY: COASTAL MANAGEMENT

NASA satellites make valuable contributions to coastal management studies. The Moderate Resolution Imaging Spectroradiometer (MODIS) (see image from Terra MODIS on the left) can be used to measure *ocean color*—the visible light that penetrates water surfaces and reflects off what is floating or dissolved there. Scientists can use ocean color measurements from MODIS and other sensors to help them estimate the amount of microscopic plant life that lives in the Chesapeake Bay (shown here) and other bodies of water. The kinds and amounts of plant life are indicators of the health of marine ecosystems. (NASA image courtesy Jeff Schmaltz, MODIS Rapid Response)

Sometimes excess nutrients can cause the waters of the Chesapeake Bay to become *hypoxic*. The decay of algae and other phytoplankton lowers the levels of dissolved oxygen in the Chesapeake Bay to a point where most animals cannot survive resulting in the formation of a *dead zone*. The map on the right shows measurements of dissolved oxygen for July 15–30, 2004. Orange and red colors correspond to the dead zone, which is estimated to cover about 40% of the bay's surface. (Map copyright Chesapeake Bay Program)



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. Increasingly, studies of the Earth focus on understanding the Earth's land, atmosphere, oceans, and life as a whole integrated system rather than as individual independent elements. NASA is an important contributor in this systems approach to Earth science studies.

In addition to providing Earth observing capabilities, NASA forms strategic partnerships with other government, academic, private, and international organizations. Through these partnerships, NASA's Earth science observations and measurements are linked to practical applications. NASA data, information, and predictive models help NASA's partners, and nontraditional users of Earth science, make timely and accurate decisions regarding management of resources and development of policy. The agency's goal is to maximize the benefit of science and technology to stakeholders by smoothly flowing Earth science data and information from NASA satellites to society.

Coastal Management

Earth's coastal regions are a precious natural resource. The United States has over 95,000 miles of shoreline that provide recreation and resources for humans; support the habitats for birds, animals and vegetation; and serve as vital ecosystems for many marine species. However, our shorelines are under stress from a number of natural and human-caused phenomena. Global warming threatens to raise the level of the oceans and inundate our coastal lands. In recent years, the incidence of harmful algal blooms (HABs) sometimes referred to as Red Tides, has increased significantly. HABs occur when excess nutrients in the water lead to explosive growth of certain rare toxic species of algae. Algae form the base of the food chain, and thus large blooms of toxic species threaten fish, shellfish, birds, marine mammals, and even humans.

Another stress to our coastal waters is *hypoxia*, which occurs when excess nutrients in the water lead to blooms of organisms that leech oxygen from the water, thus suffocating aquatic plants and animals. Over 7,000 square miles of the Gulf of Mexico and about 40% of the Chesapeake Bay area (see front) are hypoxic—two of the largest "dead zones" in the Western Hemisphere. The health of our shores has a major impact on our nation's socioeconomic well being, as more than half of our population live in coastal counties.

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 so it is difficult to offer advanced warnings. Even the warnings that are issued are not always accurate; false positive warnings of harmful algal blooms—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 NASA's Earth science 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 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 Jason-1, the Gravity Recovery and Climate Experiment (GRACE), the Ice, Clouds and land Elevation Satellite (ICESat), and the SeaWinds instrument on QuikSCAT. The succession of NASA missions over the past 25 years has allowed the agency 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. The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and its precursor, the NPOESS Preparatory Project (NPP), both joint NASA, NOAA and Department of Defense collaborations, are expected to continue NASA's long-term record of coastal monitoring into the next decade.

However, the story doesn't end with the collection of the data. These scientific observations only truly begin to serve society when they are linked to real-world applications. NASA provides data that become input for a NOAA computer simulation that attempts to recreate the actual real-world conditions in the ocean now, and how they are likely to evolve in the future. This simulation is used to predict all aspects of harmful algal blooms and hypoxia: their initiation, transport, toxic severity, landfall, and demise. Decision makers use this information to decide when they need to warn the public that a possible bloom or hypoxia event may threaten coastal areas. By incorporating NASA data into the NOAA model, forecasters hope the forecast accuracy will continue to improve and that they may soon be able to predict the landfall of these events three to four days before they occur, a major advance over current forecasting capabilities.

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