NASA Partnerships Deliver Disaster Management Resources

The following guide highlights the broad range of Earth imagery and related geospatial products available from NASA and its mission partners to increase response efficiency and effectiveness.

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Each year, natural disasters such as drought, wildfires, earthquakes, severe storms and floods exact a costly human and economic toll. In 2012, billions of dollars of damage to infrastructure and property were caused by Hurricane Sandy alone.

NASA and its partnerships with other government agencies, academic, private and international organizations contribute valuable data and information throughout the disaster management process—from preparation and response to recovery and mitigation (see "Using NASA Data for Disaster Management," page 14). By providing data, information and tools, NASA aids in reducing the overall impact of natural disasters on society as well as with evacuation and recovery efforts.

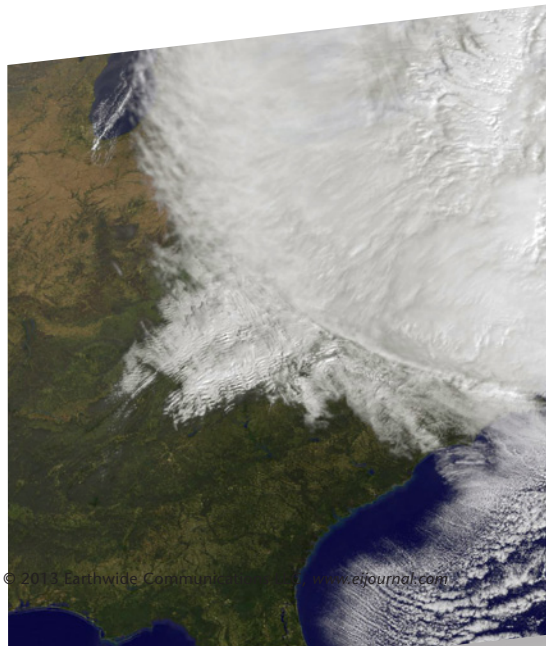
NASA works collaboratively with numerous federal agencies, including the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), National Oceanic and Atmospheric Association (NOAA), U.S. Forest Service (USFS), and U.S. Geological Survey (USGS). Such partnerships facilitate a coordinated, system-of-systems approach to disaster management across multiple agencies, using a variety of data sources to increase response efficiency and effectiveness. For information about NOAA and USGS disaster management programs and contributions, please visit *http://response.restoration.noaa.gov*, *http://hdds.usgs.gov* and *http://www.usgs.gov/natural_hazards*.

In recent years, advances in Earth science and applications, along with new data discovery and access technologies, have improved the ability to understand the risk and better predict the occurrence of natural disasters. NASA's Earth science data and models provide important input into early warning systems and decision-support models that are used for a variety of natural disasters.

NASA Programs

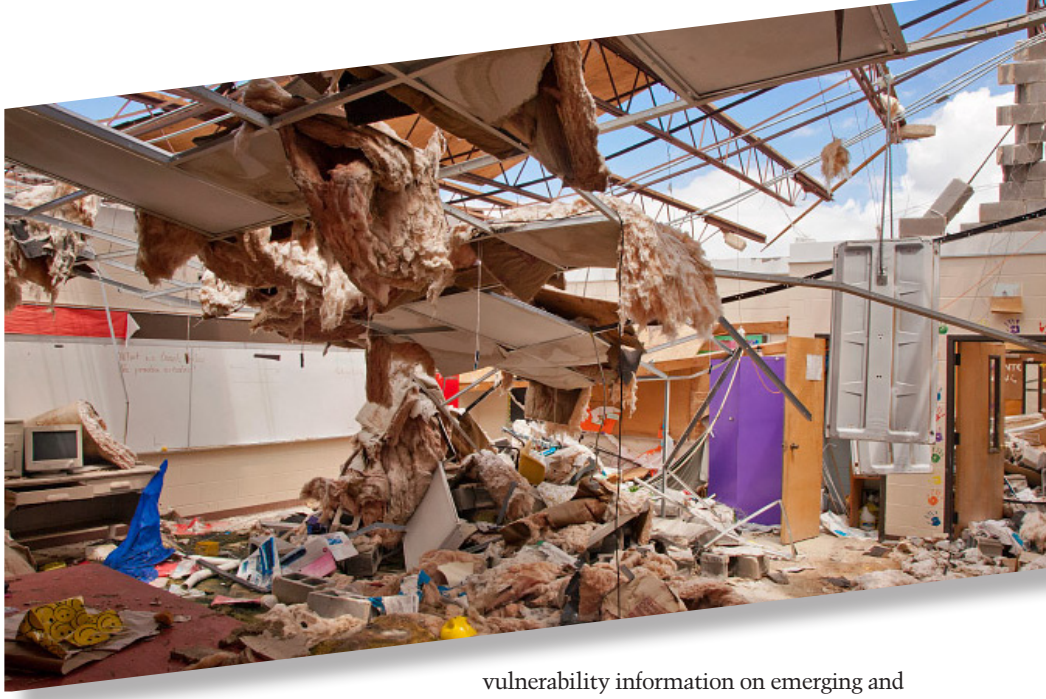
Through the use of satellite and airborne data, as well as in-situ data from NASA, partner agencies and commercial providers, remotely sensed data resources and information tools can help disaster management teams better prepare before a disaster strikes, manage the disaster once it has occurred and improve the ability to mitigate risks from natural hazards in the future.

NASA's Applied Sciences Program (*http://appliedsciences.nasa.gov*) partners with public and private organizations to determine ways to apply data from



NASA's environmental satellites and scientific findings in their decision-making activities and services. The program's portfolio of projects has applied NASA Earth science to support improvements in malaria early warning, agricultural productivity, water management, earthquake response and many other important applications.

The Applied Sciences Program currently has formal efforts under way within four applications areas: Disasters, Ecological Forecasting, Health and Air Quality, and Water Resources. The Disasters Applications focus area promotes the use of Earth observation data and tools to manage natural and technological disasters such as hurricanes, wildland fires, flooding, earthquakes, volcanoes, tsunamis and human-induced disasters such as the Deepwater Horizon oil spill.



NASA Early Warning Decision Support

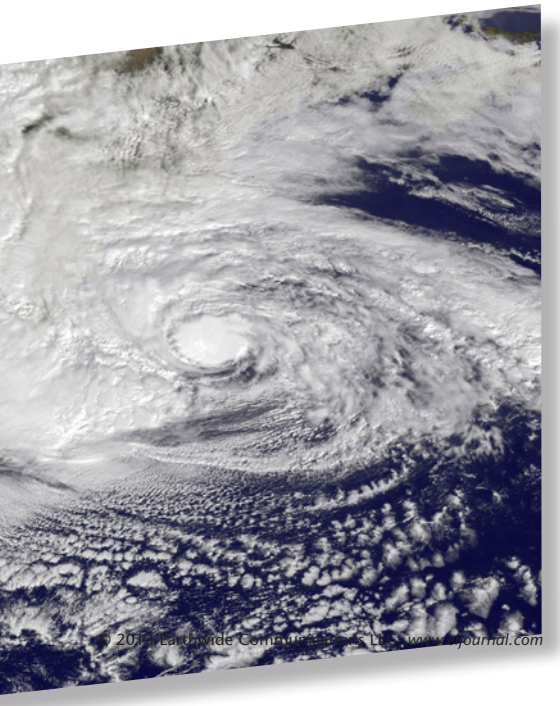
Projected changes in weather patterns are amplifying the need for enhanced decision-support tools and early warning systems so decision makers will have longer time horizons for planning and preparedness. NASA and its research partners are evaluating what remote sensing data will be most useful to help meet these needs.

SERVIR

SERVIR is a joint NASA and U.S. Agency for International Development (USAID) initiative that integrates satellite observations, ground-based data and forecast models to help developing nations in Central America, Mexico, the Caribbean, East Africa and the Himalayas improve their ability to understand and respond to natural disasters, address environmental problems, advance and improve agricultural practices and monitor air quality. The program relies on its partner agencies for expertise in scientific research and international development.

SERVIR harnesses NASA satellite data and a wide variety of near real-time, high-resolution commercial satellite images to create maps that can help governments assess environmental and infrastructural damage due to extreme events such as hurricanes, earthquakes, floods and landslides. SERVIR team members gather and process satellite data, combine the data with ground observations, analyze results and quickly pass along the information to local scientists, educators and foreign government leaders.

In addition to 38 national governments, SERVIR works with other entities to perform its mission, including the Kenya Meteorological Department and the United Nations Platform for Space-Based Information for Disaster Management and Emergency Response. For more information, visit *www.nasa.gov/mission_pages/servir*.



FEWS NET

The Famine Early Warning Systems Network (FEWS NET) is a USAID-funded activity that collaborates with international, regional and national partners to provide timely and rigorous early warning and vulnerability information on emerging and evolving food security issues. FEWS NET professionals in Africa, Central America, Haiti, Afghanistan and the United States monitor and analyze relevant data and information to identify potential threats to food security.

NASA and its partners, including USGS, NOAA and the U.S. Department of Agriculture (USDA), provide accurate and timely data products into FEWS NET. NASA's data on long-term changes in rainfall, vegetation, reservoir height and other climate factors significantly enhance USAID's ability to accurately predict food shortages and disseminate these findings in a timely manner. For more information, visit *www.fews.net.*

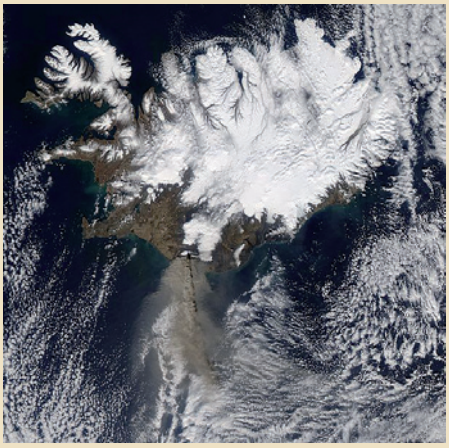
NASA's Earth science data and models provide important input into early warning systems and decision-support models that are used for a variety of natural disasters.

Availability of NASA Earth Science Data

NASA's Earth Observing System Data and Information System (EOSDIS) is a distributed system of 12 Distributed Active Archive Centers (DAACs) located throughout the United States. These institutions process, archive, document and distribute data from NASA's past and current Earth observation satellites, airborne platforms and field measurement programs.

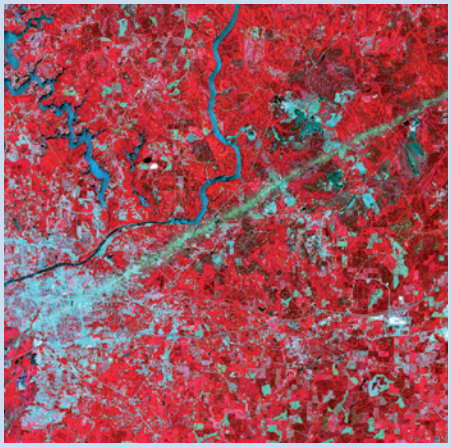
Each center is distinguished by the specific discipline it serves. Acting in concert, the data centers provide reliable, robust services to users whose needs may cross the traditional boundaries of a science discipline while continuing to support the particular needs of users within distinct science

Using NASA Data for Disaster Management



MODIS Rapid Response Team/J. Schmaltz

A MODIS image collected April 17, 2010, shows the ash plume from Iceland's Eyjafjallajökull volcano, which sent ripple effects around the globe as it halted international flights to and from Northern Europe.



NASA Land Processes DAAC at USGS EROS/K. Duda

ASTER was tasked to observe Alabama on May 4, 2011, revealing a tornado track passing through light blue Tuscaloosa at lower left and extending to the upper right. The full ASTER acquisition strip on this date included numerous tornado tracks and was used to create maps of affected areas.

LANCE MODIS Rapid Response

On May 2, 2013, the MODIS sensor on NASA's Aqua satellite captured this view of the Panther and Cedar wildfires burning near California's Lassen Volcanic National Park. Red outlines indicate hot spots where MODIS detected unusually warm surface temperatures associated with fires.

Volcanic Ash

NASA's Earth Sciences Division's Applied Sciences Program supplies Earth observation data and information to NOAA to support the U.S. Volcanic Ash Advisory Centers (VAACs) in Washington, D.C., and Anchorage, Alaska. The VAACs, part of a system of nine centers worldwide, were established in the 1990s to detect, measure and provide near real-time data about volcanic eruptions. Although major eruptions are infrequent, when they do occur, aviation safety officials rely heavily on VAAC data.

Typically VAAC data products and information are combined with National Weather Service (NWS) data to estimate the extent and concentration of ash plumes and determine areas where flying conditions may be hazardous. The aviation community uses the results to adjust flight routes and schedules to keep within safe limits.

One example of this is the April 2010 eruption of Iceland's Eyjafjallajökull volcano, which led to the cancellation of more than 100,000 flights. NASA observations weren't used at the London VAAC prior to the 2010 eruption; however, on April 19, seven days after the eruption began, the London VAAC began to use a variety of NASA Earth observation data products for the first time to open closed airspace more quickly.

Tornadoes

On April 27, 2011, an EF-4 tornado touched down in Tuscaloosa, Ala., with maximum wind speeds measured at 190 mph. The resulting damage stretched 80.3 miles long and as much as 1.5 miles wide in places.

Surveying this type of damage required a larger perspective than just aerial and ground surveys. To provide a larger context, NASA's Short-term Prediction Research and Transition Center (SPoRT) project made NASA Moderate Resolution Imaging Spectroradiometer (MODIS) data available at 250-meter resolution to the Advanced Weather Interactive Processing System (AWIPS), which is a complex network of systems that ingests and integrates meteorological, hydrological, satellite and radar data. AWIPS processes and distributes the data to Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs) nationwide.

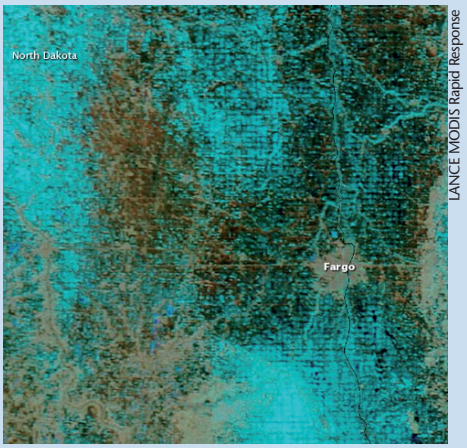
The NASA SPoRT team and much of Northern Alabama were affected by a large power outage for almost a week after the tornado outbreak. However, once SPoRT resumed operations, WFOs BMX and HUN worked with SPoRT to acquire imagery in KML format, responding with channel-differenced before-and-after MODIS imagery. Then 15-meter Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery provided ground-truth information to help determine damaged areas. As a result, disaster management teams were able to correlate damage locations and Doppler radar rotational signatures.

Wildfires

NASA provides satellite data as well as airborne data and information support for wildland fire management teams. New for the 2013 wildland fire season, NASA and U.S. Forest Service (USFS) scientists at Ames Research Center in Moffett Field, Calif., have installed the Autonomous Modular Sensor (AMS) on a Cessna Citation aircraft that belongs to USFS. This scanning spectrometer is designed to help detect hot spots, active fires, and smoldering and post-fire conditions. Developed by NASA's Airborne Sciences Program, AMS acquires high-resolution imagery of Earth's features from its vantage point aboard research aircraft. The sensor transmits near real-time data to ground disaster management investigators for analysis.

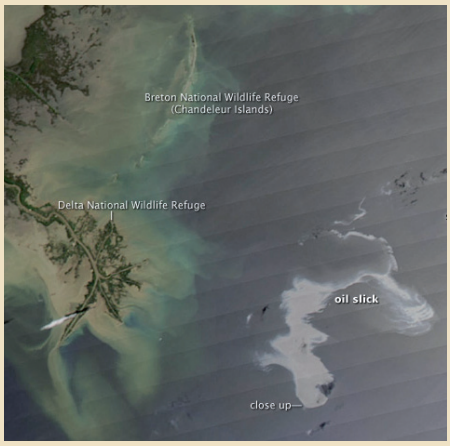
Near real-time Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data and imagery also are used to help wildland fire management teams mobilize fire-fighting and natural resource management resources around the world. NASA's Land Atmosphere Near-Real Time Capability for EOS (LANCE) system provides data to the NASA Fire Information for Resource Management System (FIRMS), a service that uses remote sensing and geographic information system technology to deliver global MODIS hotspots/fire locations in an e-mail alert. Since FIRMS was launched in January 2007, subscribers to the fire alerts have grown from 580 to 4,064.

NASA's satellites and related geospatial data are useful for a range of disaster management situations. The projects and events below showcase the use of Earth observations in ways that provide societal and economic benefits.



LANCE MODIS Rapid Response

A MODIS image reveals the extent of springtime flooding in Fargo, N.D., where water often swamps nearby farmland. Collected April 26, 2013, the image uses a combination of infrared and visible light to increase contrast between water and land. Snow is bright turquoise. Water is navy.



MODIS Rapid Response Team

An estimated 42,000 gallons of oil per day were leaking from an oil well in the Gulf of Mexico in late April 2010, following an explosion and eventual sinking of the Deepwater Horizon offshore drilling rig. The Mississippi Delta is at the center of this MODIS image, and the oil slick is a silvery swirl to the right.

Floods

Mapping floodwater extent for active floods is critical for local and regional officials as well as for disaster relief organizations that need to ascertain where to focus their efforts. Satellite data play an essential role in assessing flood extent and flood rates.

For example, Landsat imagery, distributed by USGS, is used by local emergency managers to assess flood conditions. Near real-time Moderate Resolution Imaging Spectroradiometer (MODIS) data are used to create flood maps. NASA's Land Atmosphere Near-Real Time Capability for EOS (LANCE) system provides MODIS data to the Dartmouth Flood Observatory and the NRT Global MODIS Flood Mapping initiative. The NASA MODIS data are used to revise or confirm 24-hour forecasts related to weather systems approaching the land from the oceans, providing more reliable flood warnings.

Also, in the wake of many natural disasters, disaster relief, humanitarian aid and health officials, as well as members of the news media, tap into a unique set of NASA data products that describe the location of exposed populations in relation to natural hazards and hazardous events. These global data sets—Cyclone, Drought, Earthquake, Flood, Landslide and Volcano hazard frequency, distribution, mortality and economic risk—and gridded population data are made available through NASA's Socioeconomic Data and Applications Center. For more information, visit *http://sedac.ciesin.columbia.edu.*

Technological Disasters

The 2010 Deepwater Horizon oil spill in the Gulf of Mexico is an example of how data from multiple agencies can and should be used to improve response operations during marine oil spills. A combination of both satellite and airborne sensor data products were used to measure the extent of the oil spill and classify the variability of the oil spill's characteristics. NASA satellites and airborne platforms measured the extent of the spill daily.

The remotely sensed data were useful in that the extent of the oil slick is most easily viewed and tracked using visible channels or through a combination of channels, but it also can be detected at night in the infrared spectrum. The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument's infrared capability is sensitive enough to detect changes in surface temperatures between oil/water emulsion and the surrounding Gulf of Mexico waters. MODIS visible images detected the presence of oil due to the sun glint reflecting off the oil, and MODIS infrared images at night detected the presence of oil because the evaporative cooling of the oil is cooler than the surrounding water temperature.

disciplines. For information about NASA EOSDIS data centers and their disciplines, visit *http://earthdata.nasa.gov.*

Near Real-Time Data Access

NASA's Land Atmosphere Near Real-Time Capability for EOS provides access to free near real-time NASA data (<3 hours from observation) from multiple data sources, including NASA's Earth Observing System (EOS) satellites Terra, Aqua and Aura. Such timely data are useful for a range of applications—e.g., to detect wildland fires; track smoke, ash and dust plumes; monitor aerosols, carbon monoxide and sulfur dioxide, which in turn are useful for air quality assessments; and determine the extent of sea ice, snow and flooding. For more information, visit *http://earthdata.nasa.gov/data/near-real-time-data.*

Creating a System of Systems

Disaster management teams face many challenges. It's not always clear what data, information and tools are available; how to tap into these tools; or how to find, process and interpret the data in a timely manner. Then there are

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the unique challenges per event, observation types and requirements vs. disaster types. User-based challenges are also important considerations—near real-time availability, interoperability across communities, ease of use for discovery and access tools, and data delivery.

By creating data and access standards across communities and by working together as one disaster response system of systems, agencies and emergency management teams can improve their level of preparedness before a natural disaster occurs. Such an approach also allows them to enhance the efficiency and effectiveness of their response during recovery and, by analyzing a combination of remotely sensed satellite, airborne, socioeconomic and in-situ data, better mitigate natural hazard risks for the future.