When waters rise: NASA improves flood safety

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In the spring of 2011, heavy rains and snow pack resulted in record releases from dams in Montana and the Dakotas, and near-record flooding along parts of the Missouri River. One especially hard-hit community was Hamburg, Iowa, where levee failure in early June caused extensive flooding and the evacuation of many homes. By late June, the US Army Corps of Engineers had rebuilt the levees and Hamburg was protected from additional flooding. This image acquired on Aug. 2, 2011, was taken by the Enhanced Thematic Mapper Plus on Landsat 7. Credit: US Department of the Interior/USGS, NASA

Flooding is the most frequent and widespread weather-related natural disaster, taking a huge toll in lives and property each year. NASA Earth-observing satellites and airborne missions provide vital information to emergency planners, relief organizations and weather forecasters, helping to improve flood monitoring and forecasting, as well as providing a more comprehensive understanding of one of Mother Nature's most damaging hazards.

NASA's Earth-observing satellites provide detailed images of flood-affected areas, which are vital for mapping flood extent. For instance, the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on NASA's Terra and Aqua satellites monitor a broad area of our planet, providing visible-light imagery, infrared information and other types of data on a daily basis to scientists and emergency managers. The Landsat satellites in partnership with the U.S. Geological Survey provide even higher-resolution imagery, which can be used to map Earth's land surfaces before and after disasters. Landsat serves as an essential tool for assessing flood risk and mapping the extent of damage for post-disaster recovery. Earth Observing-1 (EO-1) is an advanced land-imaging mission that includes three advanced land imaging instruments and five revolutionary cross cutting spacecraft technologies.

The United Nations World Food Programme, which delivers food relief to inundated areas, uses NASA Earth science satellite-based flood maps to locate floods and map delivery routes to affected areas. Contractors with the U.S. Federal Emergency Management Agency (FEMA) also use Landsat imagery to track urban development, which can affect an area's flood risk.

These maps, which reveal the extent and duration of a flood, also allow for more accurate flood forecasting models. "By mapping floods, we can model where future floods will be," said Bob Brakenridge, director of the Flood Observatory at the University of Colorado, Boulder, which has documented flooding events worldwide over the past 14 years. If an area floods year after year, then scientists can predict the likelihood and severity of flooding in surrounding lands.

NASA satellites also provide precipitation measurements, which play an important role in flood monitoring. "If you can see very high rainfall rates in certain regions, that can feed into [flooding] models," said Eric Wood, a hydrologist at Princeton University, Princeton, N.J. Data from NASA's Tropical Rainfall Measuring Mission, known as TRMM, allow scientists to model surface runoff and river discharge, helping predict floods and landslides.

In late February, NASA and the Japan Aerospace Exploration Agency launched the Global Precipitation Measurement (GPM) mission's Core Observatory, which will provide unprecedented data on rain and snowfall and significantly contribute to flooding research. GPM will allow scientists to estimate the sizes of precipitation particles and detect a large range of precipitation rates. "GPM will go a long way with improving the accuracy of rainfall measurements," said Wood.

The GPM Core Observatory will collect information that unifies and improves data from an international constellation of existing and future satellites by mapping global precipitation every three hours.

In November, NASA will launch a satellite that will help improve flood models by directly measuring global soil moisture. The Soil Moisture Active Passive, or SMAP, mission will contribute soil moisture data to flash flood guidance maps, which are used daily by forecasters and meteorologists to predict floods. Measurements of surface soil moisture are critical data for general weather and precipitation forecasts. They are especially important for developing flood prediction models, as soil moisture is a key determinant of how much precipitation is absorbed in the soil and how much runs off into lakes, streams and oceans.

SMAP will be able to easily detect if a surface is covered with water or not, which is very helpful in distinguishing flooded regions from non-flooded regions, said Dara Entekhabi, SMAP science team leader at the Massachusetts Institute of Technology, Cambridge. The satellite will also distinguish between frozen and thawed land.

Researchers, armed with precipitation and soil moisture data as well optical and infrared imagery from NASA satellite instruments, are able to build on current flood monitoring and forecasting systems and improve flood awareness. Researchers look to NASA satellites such as Landsat, TRMM, Suomi-NPP, CloudSat, Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), Aqua, Terra, GPM and SMAP, to name a few. These satellites have helped or will help advance flash flood guidance systems, flood mapping, landslide research, flood crop loss assessments, and national and local disaster preparedness and response efforts.

"These applications are all innovative uses of NASA research satellite data which the science community is using to help better safeguard lives and property world-wide," said John Murray, NASA's Applied Sciences Program, Disasters Area Associate for Meteorological Applications at NASA's Langley Research Center in Hampton, Va.

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