Satellite-based flood monitoring central to relief agencies' disaster response

July 22 2015, by Ellen Gray

Flooding in Malawi in January 2015 submerged houses and farmland. Credit: UNDP/George Ntonya

In January 2015, the Shire River in Malawi, and Zambezi River in Mozambique were under tight scrutiny. Weeks of torrential rains led

these and other rivers to burst their banks displacing 390,000 people across the region. In southern Malawi 220,000 acres of farmland were turned into a lake, cutting off roads and stranding thousands of people on patches of high ground. The flood was devastating for the country, but within 72 hours of it being declared an emergency the United Nations World Food Programme (WFP) was on the ground distributing food to residents.

The quick response was supported by early warnings from the WFP's Emergency Preparedness & Support Division in Rome where meteorologist Emily Niebuhr and her colleagues had been monitoring Malawi's weather and the flood waters. And they were doing that with tools that were developed with data from NASA satellites.

Floods are one of the most devastating and costly natural disasters, each year on average affecting 96.9 million people worldwide and causing $13.7 billion in damage, according to the United Nations Office for Disaster Risk Reduction. They wash away or destroy homes, pollute drinking water, and in the case in Malawi wipe out croplands for an already struggling population. Diseases like water-borne cholera can follow in their wake.

In developing countries with limited infrastructure, locating flood waters in order to assess the risk it poses to people – and help decision-makers prioritize aid efforts – is one of the most important jobs of weather forecasters at WFP. But it's not always easy. Flood and rainfall information varies widely by country, Niebuhr said. Sometimes it's not available at all.

That's why the World Food Programme turns to satellite-based tools to help evaluate ground conditions. Data from weather satellites and NASA's precipitation satellites – the Global Precipitation Measurement (GPM) mission and the recently decommissioned Tropical Rainfall

Measuring Mission (TRMM) – are very useful, said Niebuhr. But the real value of the data is exploited when they are incorporated into flood monitoring and prediction tools like the Global Flood Monitoring System, produced by the University of Maryland.

"The Global Flood Monitoring System provides one key step further by indicating how an excess rainfall event will impact river flow, and also whether there is a potential for flooding downstream away from the heavy rain event," said Niebuhr.

Where heavy rains unfold, floods follow. That was an observation Bob Adler, a precipitation and hydrology researcher at the University of Maryland in College Park, began to see in satellite rain data from the TRMM mission in the early 2000s. At that time, scientists had just begun combining TRMM data with rain data from other weather and NASA research satellites into a single data product. This product observed all the rain in the tropics, sub-tropics and lower mid-latitudes every three hours. Scientists found that it was very useful for looking at near-real time events on the ground, like floods.

"The idea was to combine the rainfall information we had with [hydrologic] models," Adler said. Hydrologic models hold information about the type of soil, soil moisture, vegetation, slopes, rivers, and streams, among other factors that affect whether a region will flood.

"If you have a fairly accurate measure of how much rain water is coming down to the surface of Earth, the model helps to determine how much is going to soak in, how much is available to runoff [over the land surface to streams], and you follow the water downstream," Adler said. For each point along the path, whether over land or in a river, the computer model estimates the amount of water present. Three hours later it does it again.

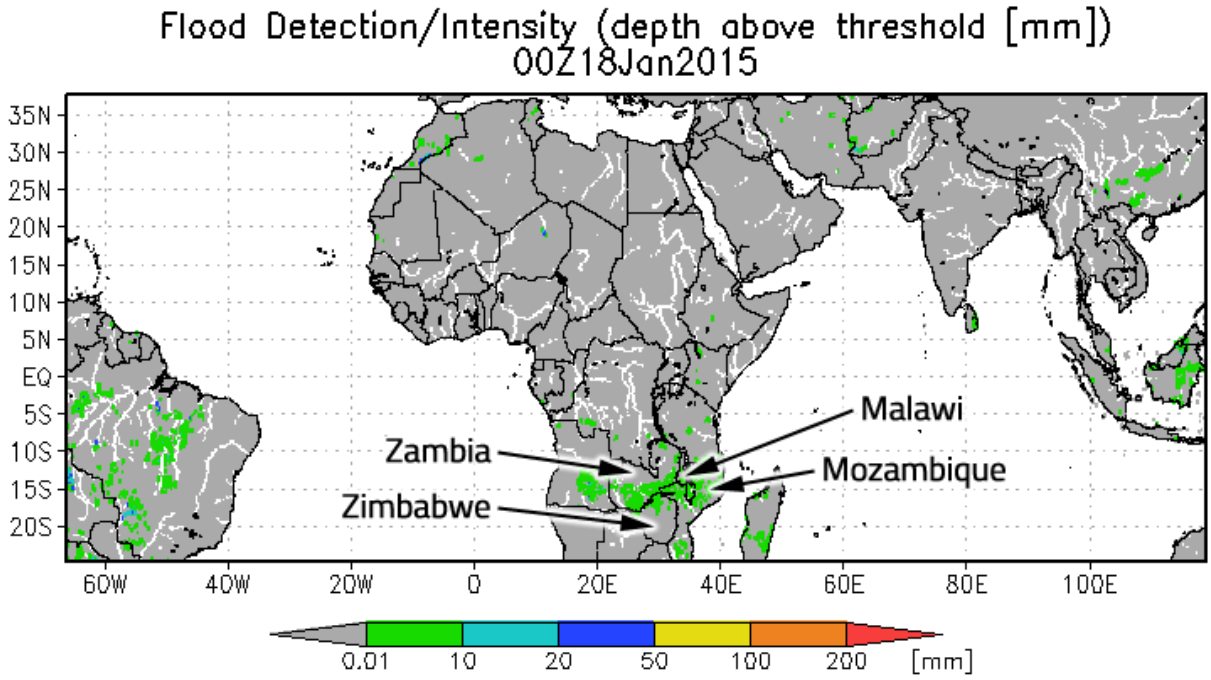
The end product is a series of maps produced in three-hour time-steps

that track the water's progress for the duration of the flood – from the initial rainstorm through the flood's build-up and recession. The data describe the height of the water in streams and rivers, whether they are above the threshold for floods to occur, and the depth of any flood waters that have spread beyond their banks. The team also puts out a five-day flood forecast.

The satellite-based estimates are tested against flood events in countries like the United States, where the National Weather Service has excellent information from ground radar and ground measurements. In May, Adler and his colleague Huan Wu compared their estimates from the Global Flood Monitoring System to the Weather Service maps produced for the floods in Texas and Oklahoma.

"We did a good job on estimating the extent and [identifying] which rivers were affected," said Adler, "but it wasn't perfect." In general, over certain types of rough terrain, the satellites can underestimate precipitation, and ground information for the model can always be improved, he said.

However, for areas and countries without extensive weather and monitoring networks on the ground, the satellite-view of floods is the only way to see what's happening. The Global Flood Monitoring System is widely used by the research community, insurance and reinsurance groups, and humanitarian organizations like the International Red Cross and the U.N. World Food Programme.



Malawi, Mozambique, Zambia and Zimbabwe flooding on Jan. 18, 2015, are shown in green on the flood map from the Global Flood Monitoring System. Credit: GFMS/University of Maryland

"We check the GFMS nearly every single day to monitor current flood concerns, and also to assist in discovering new flood events that may not have been reported yet or are developing," Niebuhr said. "We also rely heavily on the [U.N. and European Commission's Global Disaster Alert and Coordination System] Global Flood Detection System and the Dartmouth Flood Observatory for additional monitoring of river level and flood extent, and both groups rely heavily on data from NASA satellites."

For example, the Dartmouth Flood Observatory uses direct observations of flood water extent from instruments like MODIS, the Moderate resolution Imaging Spectroradiometer on NASA's Terra and Aqua

satellites. This method complements the precipitation data Adler's Flood Monitoring System relies on, allowing the scientists to compare results and ultimately improve their individual flood estimates.

For the future, Adler said, the question is how do you link all this information together to get a really robust flood prediction and monitoring system.

Rains began at the end of December and continued into January, flooding southeast Africa, including Malawi. Credit: UNDP/Arjan van de Merwe

In the meantime, Niebuhr and her colleagues will continue to use the satellite-based tools they have to organize the best response possible for

flood emergencies. During the first six weeks of the crisis in Malawi, the World Food Programme distributed food and assistance to 370,000 flood victims, reaching people by helicopter where roads were washed out.

For emergency managers working on the ground in Malawi or other flooded communities, she said, "this data is essential for filling local gaps in observed flood data."

More information: For more information about the Global Flood Monitoring System, visit: flood.umd.edu/

Provided by NASA