How Landsat Helps: DISASTERS

A long exposure photograph taken during a 2013 eruption of Sicily's Mount Etna. A July 2001 eruption of Mount Etna triggered the first Charter call for a volcano emergency.

Mapping Disaster: A Global Community Helps from Space

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Year after year, somewhere on Earth, natural or manmade disasters cause loss of life and widespread destruction, frequently spawning refugee situations. Though the risk of a disaster is low in any one particular place, earthquakes, volcanoes, floods, fires, landslides, oil spills, and hurricanes—when considered together on a global scale—regularly menace people, property, and natural resources.

Major disasters can temporarily make existing maps obsolete, rewriting river boundaries, shorelines, and land features in an instant. When disasters strike and first responders need to understand new situations on the ground, the best source of information often comes from the sky. Satellites, like Landsat, can tell responders what damage disasters have done, providing timely insight into flood extents, fire boundaries, lava flow directions, road traversability, and oil slick movements.

Taking Action

After devastating Hurricane Mitch swept through Central America in 1998 leaving 20,000 dead in its tracks, space agency leaders decided to take action and use their specialized resources to try to lessen the impact of future disasters.

Hurricane Mitch, a category 5 hurricane, ripped through Central America leaving a devastating trail of destruction. This image shows the aftermath of Mitch's flood damage along the Choluteca River in Tegucigalpa, Honduras. The storm spurred the idea for the Charter. Photo credit: Debbie Larson, NOAA's National Weather Service

Photo Information

Above: A flood rescue effort along Honduras' Choluteca River after Hurricane Mitch. Photo credit: Debbie Larson, NOAA's National Weather Service

Image Information

Landsat images, like this Landsat 5 image acquired on Sept. 7, 2005, were among the space-based image resources used to monitor the receding floodwaters caused by Hurricane Katrina in New Orleans.

In 1999, at the Third United Nations Conference on the Exploration and Peaceful Use of Outer Space (UNISPACE III) in Vienna, the European Space Agency (ESA) and the French space agency (CNES) proposed a system to supply free satellite imagery to emergency responders anywhere in the world. The outcome was the creation of the International Charter Space and Major Disasters; "Charter" for short.

The Disaster Charter concept is this: a single phone number is made available to authorized parties providing 24/7 contact to a person who can activate the charter. Once activated, a project manager takes charge. The project manager knows what satellite resources are available, how to task them to collect data, and how to quickly analyze the collected data to create impact maps for first responders. These maps, provided to responders for free, often show where the damage is and where crisis victims are, allowing responders to plan and execute relief support.

You can think of the Charter as a one-stop-shop for impact maps—an essential resource, since in many cases satellite data are the only practical method to assess current ground conditions after a disaster.

Today, 15 space agencies and more than 30 satellites are part of the Charter, pooling their combined resources to ensure that spacefaring nations can quickly share their data for a humanitarian undertaking. Since its inception, the Charter has been activated more than 400 times.

U.S. Participation

While the U.S. was not originally part of the Charter, the National Oceanographic and Atmospheric Administration—with its mighty fleet of meteorological satellites—soon became a member in 2001. The U.S. Earth-observing satellite fleet, including Landsat, was not officially part of the Charter until the U.S. Geological Survey joined in 2005.

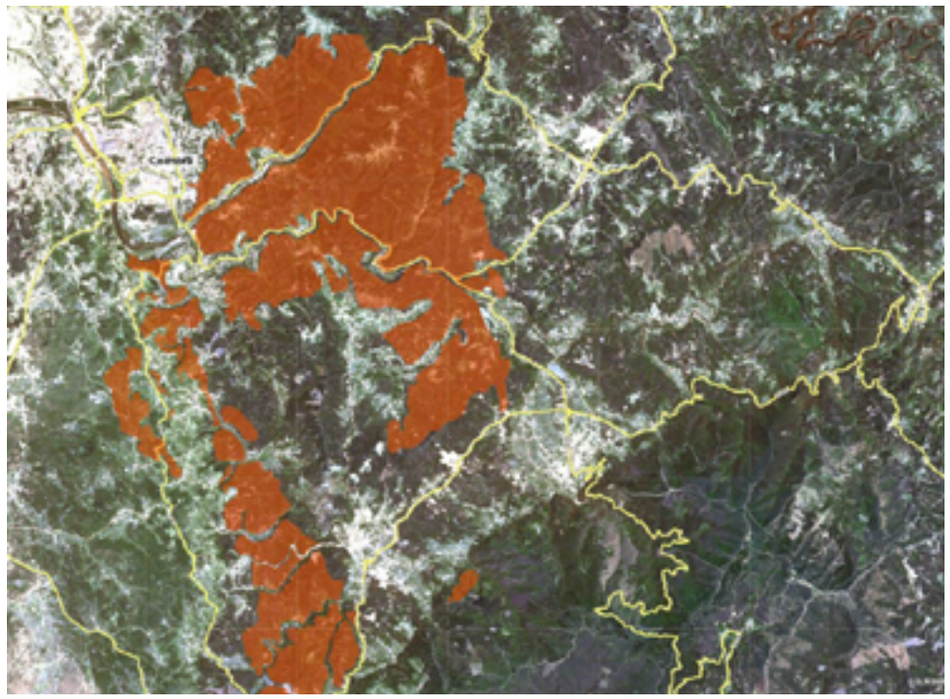
However, Landsat imagery was regularly used from the beginning, with other Charter space agencies providing Landsat data downloaded to their ground receiving stations or purchasing Landsat data from the U.S. archive.

Landsat was used during the very first charter activation. That first call came in November 2000 after a large landslide in Slovenia. After weeks of torrential rainfall, a small landside dammed up the Mangart Stream near the Italian boarder. The resulting pooled waters worked in tandem with the saturated slopes of Slovenia's Mount Mangart to cause the mountainside to give way overnight. An estimated 1 million cubic meters (35 million cubic feet) of debris flowed into the Soca River, devastating a small village and killing seven people en route.

The Charter was activated a few days later. Thirteen satellite images were used, including two Landsat images taken before the disaster. All of the satellite images were gathered into a geographic information system (GIS) where the damage was analyzed. Using Landsat and SPOT imagery, a land use map was quickly created. This helped data analysts show responders that, although the majority of damage occurred in areas covered by deciduous forest, there was also significant damage in agricultural and inhabited areas.

In July 2001, the first volcano Charter activation was requested by the Italian Civil Protection Agency for an eruption of Sicily's Mount Etna. Again Landsat and SPOT images were processed along with radar images. The Landsat thermal bands were used to map thermal anomalies before and after the July 26 eruption. These maps helped authorities forecast lava flows threatening human populations on the mountain slopes and to determine risks of new vents.

A year later, in 2002, at the onset of the rainy season in August, the Charter was activated to aid a flood-caused refugee situation in western Sudan. Humanitarian relief organizations there found themselves in urgent need of current detailed maps.



Coimbra, Portugal's third largest city, was threatened by the 2004 wildfires (left). A Charter map of the wildfire activity near Coimbra (right).

The Disaster Charter used satellite resources to map regions around the cities of Al Fashir and Al Junaynah to ascertain road networks and conditions and to find out what was traversable in the flood conditions. Landsat, SPOT, and ENVISAT-ASAR (radar) satellite imagery were used to accomplish this.

Then in late 2004, a magnitude 9 earthquake triggered a devastating tsunami that affected Sumatra, Thailand, Sri Lanka, and southern India, killing more than 200,000 people. The Charter was activated three times to cover the large expanse of damage. Both medium resolution data (Landsat, SPOT, Disaster Monitoring Constellation) and very high-resolution data (IKONOS, Quickbird) were used to map impacted areas and to calculate damage extent. This gave first responders an overview of the situation on the ground and provided them with information needed to plan relief logistics.

The U.S. Earth-Observation Fleet Joins the Charter

After the staggering devastation wrought by the Indian Ocean tsunami, Brenda Jones, a Disaster Response Coordinator with the U.S. Geological Survey (USGS) got an email from Charley Hickman, a USGS State liaison in Ohio. Hickman wanted to know why Landsat was not officially part of the Charter. Jones looked into the matter and quickly discovered that the Charter was keen to partner with USGS.

"The Charter was very interested in having USGS join because of Landsat," Jones recounts.

Thus, in early 2005, USGS became an official participating agency of the Charter. While USGS had joined because of its Landsat resources, USGS membership brought a suite of other valuable satellite data to the Charter, including NASA's MODIS, ASTER, EO-1—and even photos taken from the International Space Station.

Photo Information

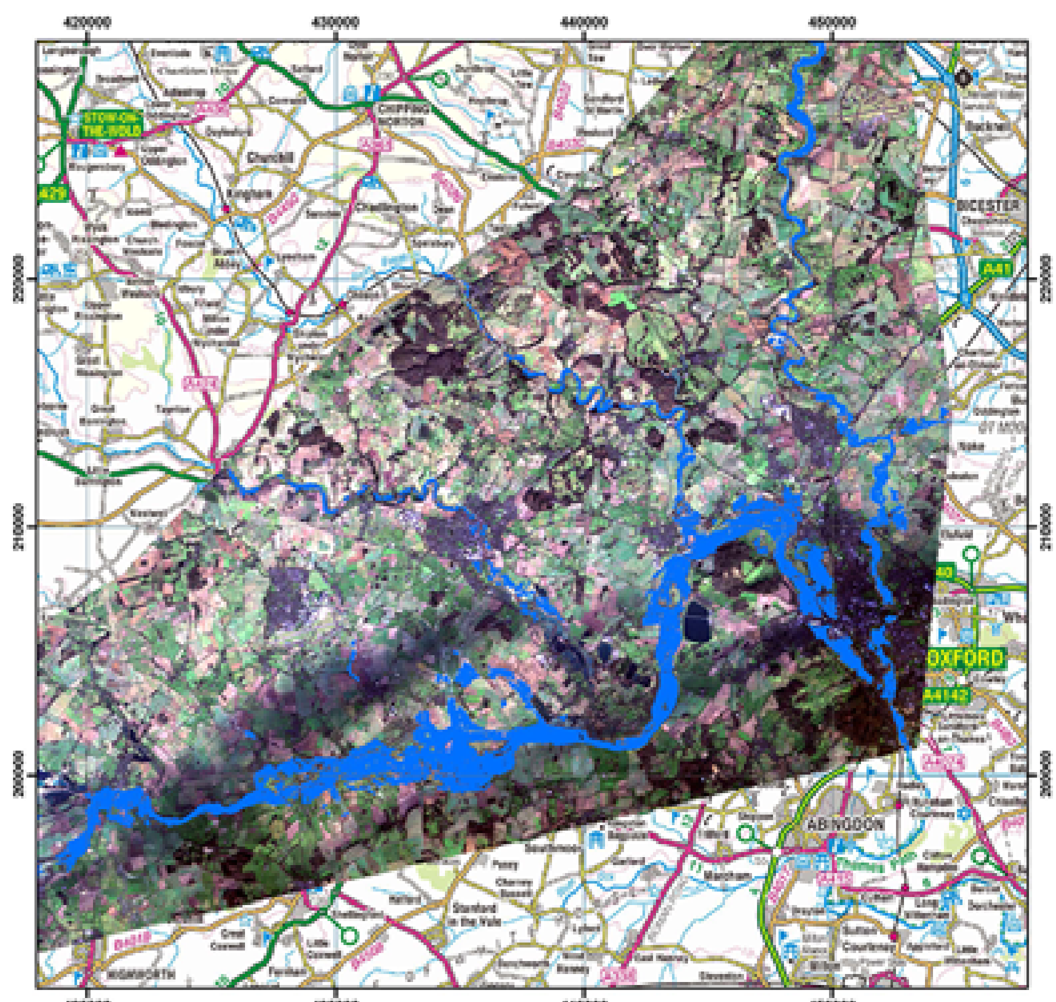
Above: The village of Log pod Mangartom was severely damaged by the 2000 landslide in Slovenia. Photo credit: Lenart & Bizjak

Photo Information

Above: Flood waters caused by Hurricane Katrina broke protective levees surrounding New Orleans, inundating many parts of the city and leaving 1,833 people dead. Photo credit: Lt. Commander Mark Moran, NOAA Corps

Additionally, commercial high-resolution vendors contribute their data through USGS.

The year USGS officially joined, severe droughts throughout the Iberian Peninsula caused vast wildfires across central and northern Portugal. The fires claimed the lives of 15 people and destroyed over 150,000 hectares (370,000 acres) of agricultural land and urban regions, eventually threatening the third largest city in Portugal, Coimbra, and prompting the Portugese fire-fighting service to request a Charter activation. Once activated, the burned areas were mapped using SPOT, Landsat, DMC, and high-resolution IKONOS data. The conflagrations were so massive, that medium resolution sensors, like Landsat, that could capture wide views of the landscape were most valuable.



The United Kingdom's Environment Agency used data acquired by Landsat 8 on Jan. 7, 2014 to map flooding of the Thames River near Oxford.

"Medium resolution satellites… proved to be more advantageous over the very high-resolution IKONOS data, which were used only for the affected urban areas," analysts later wrote.

Landsat's combination of spatial and spectral resolution together with its 186-km (115-mile) image width makes its data particularly useful after hurricanes, fires, and volcanoes, and floods.

"It is very good for getting an overall extent of the disaster. It's been very useful for the Charter," Jones shared.

In late 2008, USGS made all Landsat data freely available, so anyone in the world could download data as soon as it reached the archive, usually within hours of acquisition. Since USGS runs the Landsat Mission Operations Center and it can task Landsat satellites to acquire data whenever they are over an affected area, its involvement in the Charter remains essential.

"Really, that's one of the main reasons we are involved—to do the tasking," Jones said.

This January, Landsat data were used when the Thames River flooded. A Landsat 8 image acquired on Jan. 7, 2014, was provided to the United Kingdom's Environment Agency through the Charter. Kyle Brown, a Senior Geomatics Analyst with the agency, was the Charter project manager for the call.

Brown and his team did some of the image analysis and mapping and were able to derive flood outlines for a section of the Thames using Landsat imagery.

"The flood outline data were used at a local and national level to provide a strategic overview of the flooding and to help prioritize resources," Brown explained.

Domestically, since USGS joined the Charter, Landsat data have been used to aid in damage assessments after Hurricanes Katrina and Rita ravaged the Gulf coast—monitoring receding flood waters. Landsat imagery has also been used to map fire extents in the West, to map severe flooding in the mid-west, and to map the Gulf oil spill.

Although Landsat has been an important resource since the Charter began, its use has increased with USGS participation. "Since 2005, when USGS became a member, we have provided data for 149 activations," Jones reports.

The Charter makes Landsat one more tool in a shared toolbox of space-based resources that can be used to provide first responders with the maps they need to help save lives around the world. ■

Mount Mangart Landslide

When disasters make existing maps obsolete, satellites like Landsat can tell first responders what damage has been done and provide timely insight into flood extents, fire boundaries, lava flow directions, road traversability, oil slick movements, and landslide locations. This photograph shows the rugged terrain around Mount Mangart, the scene of the deadly 2000 landslide in Slovenia which triggered the Charter's first activation. Photo credit: Roberto Romanin

Satellite Data Requirements:

- 8-day revisit (w/ L7)
- ≤ 30 m resolution
- Vis, NIR, SWIR, TIR
- Continuous spatial coverage
- Archive continuity & consistency
- Rapid delivery of free, unrestricted data
- Geolocation of ≤ 0.5 pix