



Recommendation ITU-R RS.1859
(01/2010)

**Use of remote sensing systems for
data collection to be used in the
event of natural disasters and
similar emergencies**

RS Series
Remote sensing systems

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

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P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R RS.1859

Use of remote sensing systems for data collection to be used in the event of natural disasters and similar emergencies

(2010)

Scope

This Recommendation provides guidelines on the use of satellite-provided remote sensing data in the event of natural disasters and similar emergencies but does not provide information on dissemination of data.

The ITU Radiocommunications Assembly,

considering

- a) that disaster management in the field of radiocommunications comprises the following, equally important, aspects:
 - 1 early warning and prevention, through:
 - disaster prediction, including the acquisition and processing of data concerning the probability of future disaster occurrence, location and duration;
 - disaster detection, including the detailed analysis of the topical likelihood and severity of a disaster event;
 - 2 disaster mitigation including the rapid promulgation of imminent disaster information and corresponding alerts to disaster relief agencies;
 - 3 post-disaster relief radiocommunications, including the provision of *in situ* terrestrial and satellite communication systems to aid in securing and stabilizing life and property in the affected area;
- b) that inherent to natural disasters is the unpredictability of the site location, thus implying the need for prompt, global, Earth observing capabilities uniquely met by satellite-borne remote sensing instrumentation;
- c) that such satellite-borne remote sensors exist and are operated in frequency bands allocated to the Earth exploration-satellite service (EESS) today;
- d) that there are agencies whose purpose is to facilitate the processing and delivery of disaster-related data from the satellite operator-provider to the user relief agency,

recognizing

- a) that Resolution 647 (WRC-07) – Spectrum management guidelines for emergency and disaster relief radiocommunication, acknowledges the role of remote sensing indirectly;
- b) that Resolution ITU-R 55 – ITU studies of disaster prediction, detection, mitigation and relief, Resolution 644 (WRC-07) – Radiocommunication resources for early warning, disaster mitigation and relief operations and Resolution 673 (WRC-07) – Radiocommunications use for Earth observation applications all acknowledge the importance of the aspects of radiocommunications/ICT that are relevant to disaster prevention, prediction, detection, warning, mitigation and relief operations and identified the important role of Radiocommunication Study Group 7 and remote sensing in disaster management;

c) that Resolution ITU-R 53 – The use of radiocommunications in disaster response and relief, additionally resolves that “the concerned ITU-R Study Groups undertake studies and develop guidelines related to the management of radiocommunications in disaster prediction, detection, mitigation and relief”,

noting

a) that ITU-D Report Question 22/2 – Utilization of ICT for disaster management, resources, and active and passive space-based sensing systems as they apply to disaster and emergency relief situations is a guideline document meant to facilitate the implementation of the Common Alerting Protocol (CAP) standard for public alerting and hazard notification in disasters and emergency situations,

recommends

1 that ITU Member States should be encouraged to support the application of satellite-borne remote sensors providing useful data in the event of natural disasters and similar emergencies, such as those presented in Annex 1.

NOTE 1 – This Recommendation should be complemented by a new Recommendation on the use of collected data.

Annex 1

Use of remote sensing data from satellite-borne sensors for relief operations in the event of natural disasters and similar emergencies

1 Introduction

Meteorological aids, meteorological-satellite and Earth exploration-satellite services play a major role in activities such as:

- identifying areas at risk;
- forecasting weather and predicting climate change;
- detecting and tracking earthquakes, tsunamis, hurricanes, forest fires, oil leaks, etc.;
- providing alerting/warning information of such disasters;
- assessing the damage caused by such disasters;
- providing information for planning relief operations; and
- monitoring recovery from a disaster.

These services provide useful if not essential data for maintaining and improving accuracy of weather forecasts, monitoring and predicting climate changes and for information on natural resources. The frequencies used by those services and their associated applications are summarized in Table 1.

TABLE 1

Frequency bands used in remote sensing for disaster prediction and detection

Band (GHz)	Hazard Alloc.\	Coastal Hazards & Tsunamis	Drought	Earthquake	Extreme Weather	Floods	Landslides	Pollution (Ocean)	Sea & Lake Ice	Volcanoes	Wildfires
0.43	A	X	X	X		X	X			X	X
1.25	A	X	X	X		X	X	X	X	X	
1.42	P		X			X	X				X
1.67	P										
2.65	p		X			X	X				X
3.20	a										
4.30	p										
4.90	p		X								
5.30	A	X	X	X		X	X	X	X	X	X
6.70	p		X								
7.15	p		X					X			
8.60	A		X	X	X	X	X	X	X		X
9.60	A		X	X	X	X	X	X	X		X
10.65	P	X	X		X	X	X	X	X		
13.50	A		X		X	X	X		X		X
15.30	p										
15.40	P	X			X	X	X				
17.25	A		X		X						X
18.70	P	X	X		X	X	X				
21.30	P	X	X		X	X	X		X		
22.30	P	X	X		X	X	X				
23.80	P	X	X		X	X	X				
24.10	A		X		X	X	X				
31.50	P	X	X		X	X	X		X		
35.55	A		X		X	X	X				
36.50	P	X	X		X	X	X		X		
50.30	P	X	X		X	X	X				
55.00	P	X	X		X	X	X				
64.50	P										
78.50	A				X						
89.00	P					X	X		X		
94.00	A				X						
101.0	P		X		X						
110.0	P										
118.0	P	X	X		X	X	X				
150.5	P	X	X		X	X	X				
157.0	P										
166.0	P	X	X		X	X	X				
175.5	P	X	X		X	X	X				
183.0	P	X	X		X	X	X				
201.0	P	X	X		X	X	X				
224.0	P										
236.0	P										
251.0	P										

NOTE 1 – A and P refer to active and passive remote sensing in these frequency bands.

On-the-ground, at-the-spot (*in situ*), at-the-time measurements or observations are usually more precise and more accurate than similar observations made from space. These kinds of observations are known as “ground truth” and are used to calibrate spaceborne instrumentation. However, when *in situ* instrumentation or the supporting infrastructures necessary to use such instrumentation are not in place or have been disabled by the disaster, or the ground measurements are not accurate enough, spaceborne observations can provide useful information helpful in alleviating the effects of disasters. Spaceborne observations are particularly useful when the areas are vast, the population densities low, and the technical infrastructure is vulnerable or not well developed.

Descriptions of how data products from satellites may be useful in alleviating the effects of natural and man-made disasters follow. These descriptions are plausible; some have been demonstrated while others are operational today. This list is not exhaustive.

2 Coastal hazards/tsunami

Spaceborne sensors can help identify areas at risk by using synthetic aperture radar (SAR)-generated digital elevation models (DEMs) to locate low areas subject to flooding, or by using SAR-generated bathymetry to identify ocean bottom structure that might worsen the incoming tsunami or storm surge.

Severe weather events, such as tropical cyclones and typhoons that produce storm surges, can be tracked by weather satellites. Such tracking can be used to alert vulnerable areas of the potential danger.

The extent of the damage can be determined using moderate- and high-resolution visible/infrared imagery from satellite-borne instruments. Lower resolution SAR imagery, which is unaffected by cloud cover, can also be used to show the areas affected. The ability of SARs to penetrate clouds and provide all-weather capability is particularly useful in cloud-prone areas such as central Africa, the Amazon, and island areas such as Indonesia.

Following a 9.0 magnitude earthquake off the coast of Sumatra, a massive tsunami and tremors struck Indonesia and southern Thailand on 26 December 2004, killing over 104 000 people in Indonesia and over 5 000 in Thailand. Medium and high resolution optical images of the Aceh Province in Indonesia taken before and after the tsunami of 26 December 2004 by low Earth orbiting satellites are shown in Fig. 1. Images, such as these, provided authorities information for an assessment of the damage.

FIGURE 1

Tsunami damage in Aceh Province, Indonesia

Assessing tsunami damage in Aceh:

Landsat and QuickBird perspectives



Above: A Landsat 7 two-scene mosaic of the northern tip of Sumatra; the Aceh Province.

January 3, 2005: David Skole and the Tropical Rain Forest Information Center at Michigan State University used Landsat 7 data to aid the Indonesian government with relief efforts in the Aceh Province of Sumatra. Using Landsat 7 data collected three days after the disaster, the MSU team created regional impact maps which were used by the Indonesian government to direct relief efforts. The broad regional coverage and high spatial resolution of the ETM+ sensor made this work possible.

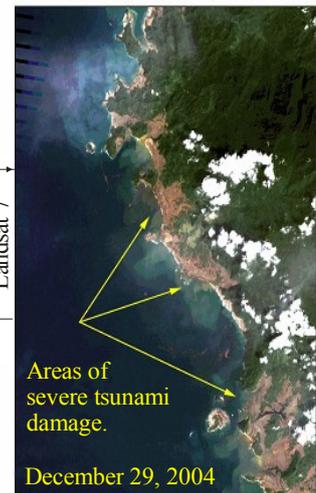


Landsat 7 -
183 km swath width
30 m spatial resolution
15 m pan-band res.

QuickBird -
16.5 km swath width
2.44 m resolution
61 cm pan-band res.



December 13, 2004



December 29, 2004



April 14, 2004



January 2, 2005

1859-01

Source: Landsat and QuickBird via the United States Geological Survey
<http://www.usgs.gov/>

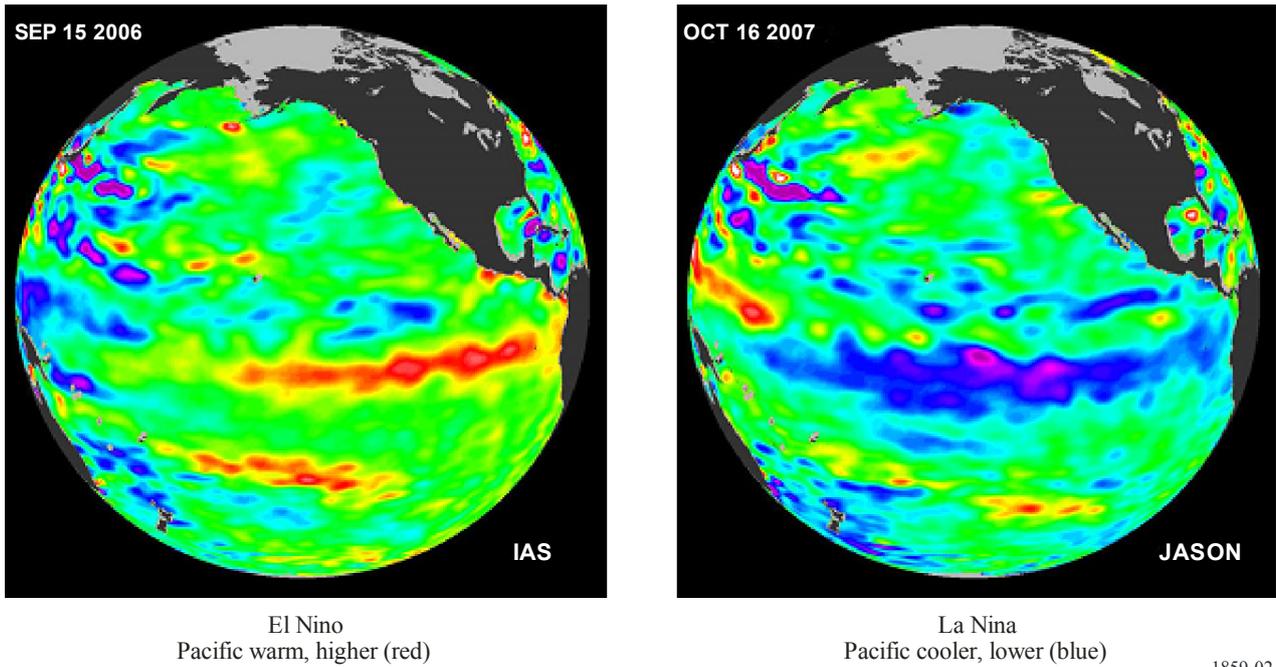
The two sets of images show the value of having two different instruments. Landsat imagery covers a larger area and helps identify regions impacted, while the QuickBird imagery shows greater detail in a much smaller area.

3 Drought

The onset and progress of a drought can be observed from space by noting soil moisture, rainfall, and the distress level of the vegetation in the affected areas. Long-range predictions of regional drought conditions can be made by tracking the Pacific Ocean temperatures, which give an indication of the onset of an el Nino event, or the opposite condition, a La Nina event.

During an El Nino event, the equatorial eastern Pacific is warmer and the ocean is high due to thermal expansion. Droughts frequently occur in Australia and Indonesia under these conditions, and the trade winds are weaker. Conversely, during a La Nina event, the equatorial eastern Pacific is cooler and the ocean height is lower due to thermal compression. The western coasts of the Americas experience dry conditions, and the trade winds are stronger. Tracking conditions in the Pacific from satellites gives warnings months in advance of an event (see Fig. 2).

FIGURE 2
El Nino and La Nina events in the Pacific Ocean

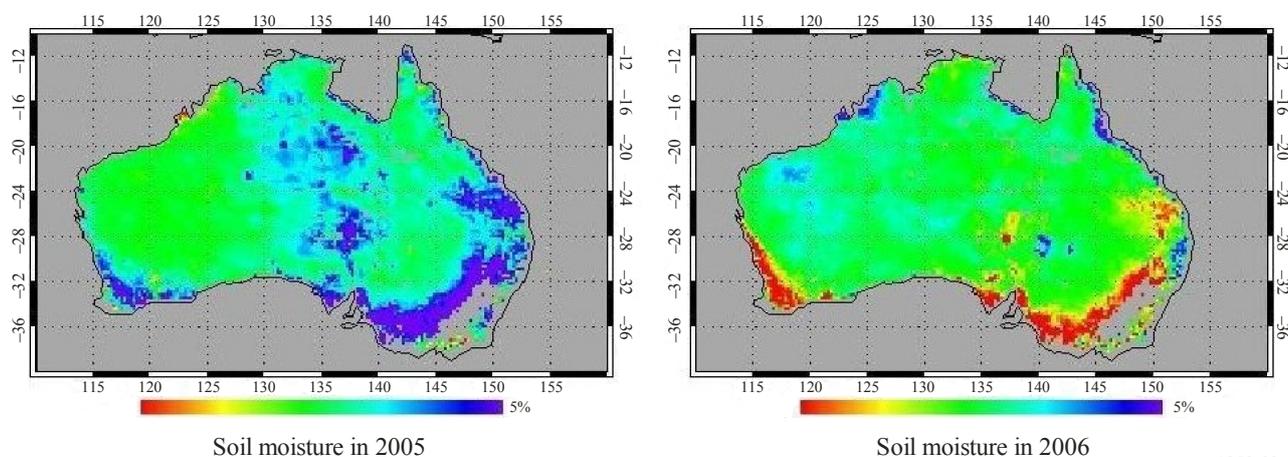


Source: JASON-1 via NASA/JPL
<http://topex-www.jpl.nasa.gov/elnino/index.html>

Figure 3 shows a yearly change of soil moisture distribution in Australia during October 2005, 2006. This data was acquired by channels of AMSR-E mounted on Aqua. Red indicates low amounts of soil moisture, while blue indicates higher amounts of soil moisture. The percentage indicated (unit of soil moisture) means the difference from averaged soil moisture for two years (2005-2006). A drought occurred in the south east area (Granary area) of Australia in 2006. This condition is consistent with the El Nino observations shown in Fig. 2.

FIGURE 3

AMSR-E measurements of drought in Australia in October 2005 and October 2006



Source: AMSR-E on AQUA

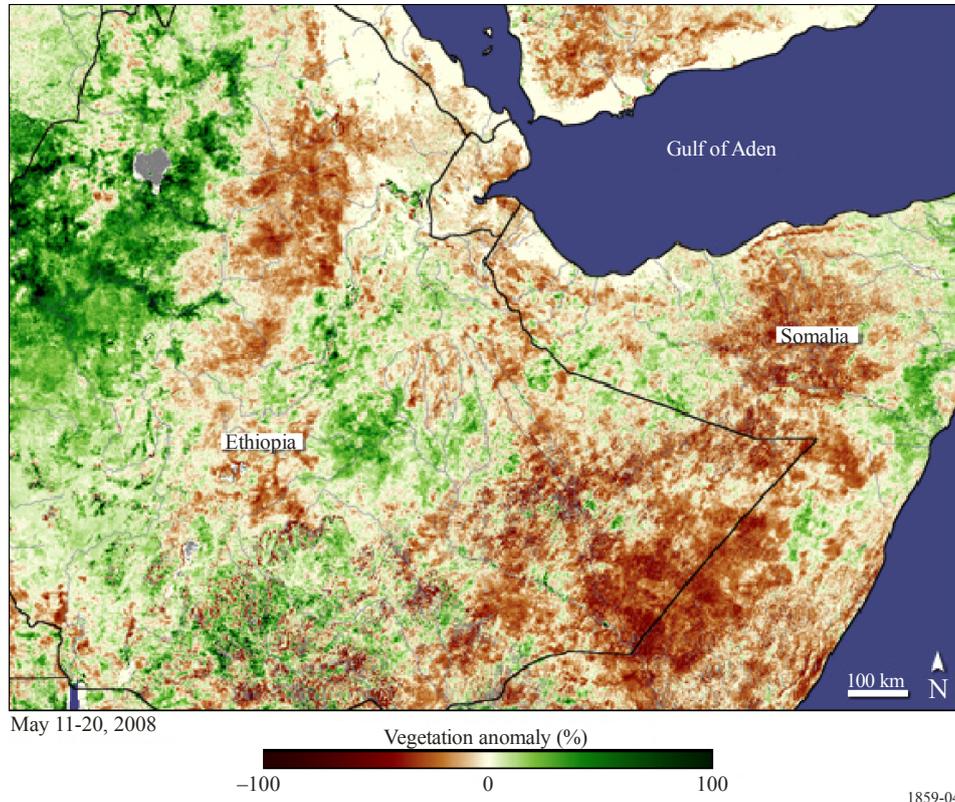
By the end of May 2008, millions faced hunger in eastern Ethiopia as crops failed and food prices soared, said the United Nations Children's Fund (UNICEF). Two successive seasons of poor rains left eastern Ethiopia in drought, and the effect on vegetation is shown Fig. 4. Made from data collected by the SPOT Vegetation satellite between 11 May and 20 May 2008, the vegetation anomaly image compares the relative healthiness of plants to average conditions. Areas in which plants were smaller, less thick, or grew more slowly than average are brown, while better than average conditions are illustrated in green.

Ethiopia presents a picture of contrasts. While the eastern half of the country withered in drought, western crop areas received ample rain and thrived. The drought limited the production of both food and cash crops like coffee, said the Famine Early Warning System Network. UNICEF estimated that 3.4 million people would need food aid in June, July and August as crops continue to fail.

FIGURE 4

Vegetation state during the Ethiopian drought of 2008

Brown indicates distressed vegetation; green indicates healthy vegetation



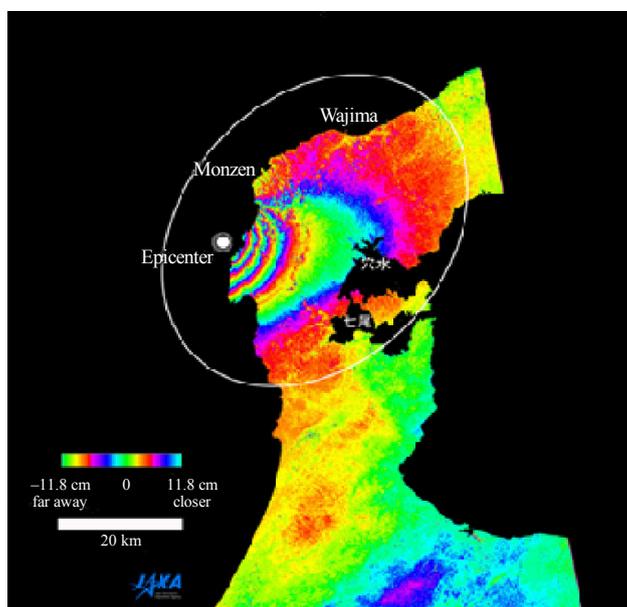
Source: SPOT via NASA

<http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=19764&oldid=14871>

4 Earthquake

After a major earthquake has occurred, the sooner an accurate damage estimate is made, the sooner the appropriate rescue assets can be mobilized. Damage-estimate decision support systems are being developed which are based on population density, type of building construction in the affected area, and the location and magnitude of the earthquake. Seismographs, interferometric SAR measurements (InSAR), and *in situ* measurements using Global navigation satellite systems (GNSS) provide a means of determining the location and extent of the rupture for use in estimating the damage.

FIGURE 5
 PALSAR measurements of change of land surface before and after
 earthquake in Noto peninsula of Japan on 25 March 2007



1859-05

Source: PALSAR via JAXA

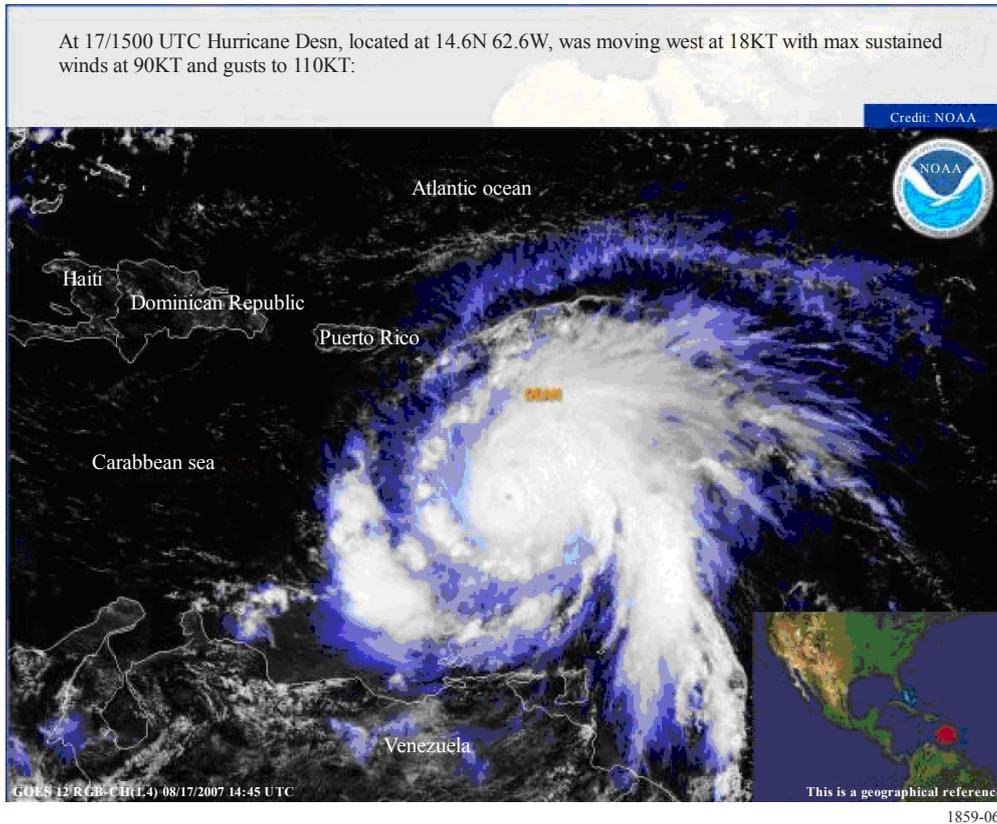
http://www.jaxa.jp/press/2007/04/20070412_daichi_e.html

Usually the ground movements associated with earthquakes are too small to appear in satellite visible or infrared imagery. However, visual imagery can be very useful in assessing the damage caused by an earthquake and in guiding rescue efforts.

5 Extreme weather

Today, operational meteorological, or weather, satellites variously called geostationary and polar orbiting environmental satellites, MetSats, etc. cover almost the entire globe. Geostationary satellites orbit at the same rate as the Earth and appear as a stationary point in the sky at an altitude of about 35 800 km. Such satellites provide superior temporal resolution with images available every 15-30 min (see Fig. 6) and support monitoring the cloud structure, extent, and overall motion of such storms. One can see where the damage has likely occurred, and forecast where the storm is going. Polar orbiting satellites typically overfly an area twice a day and provide more detailed, but less timely, observations. Much pertinent data can be obtained through the Internet. When immediate local weather information is needed, relatively inexpensive ground stations can be purchased, installed, and used to gather real-time data from satellites passing overhead.

FIGURE 6

Hurricane Dean observed by GOES from geosynchronous altitude

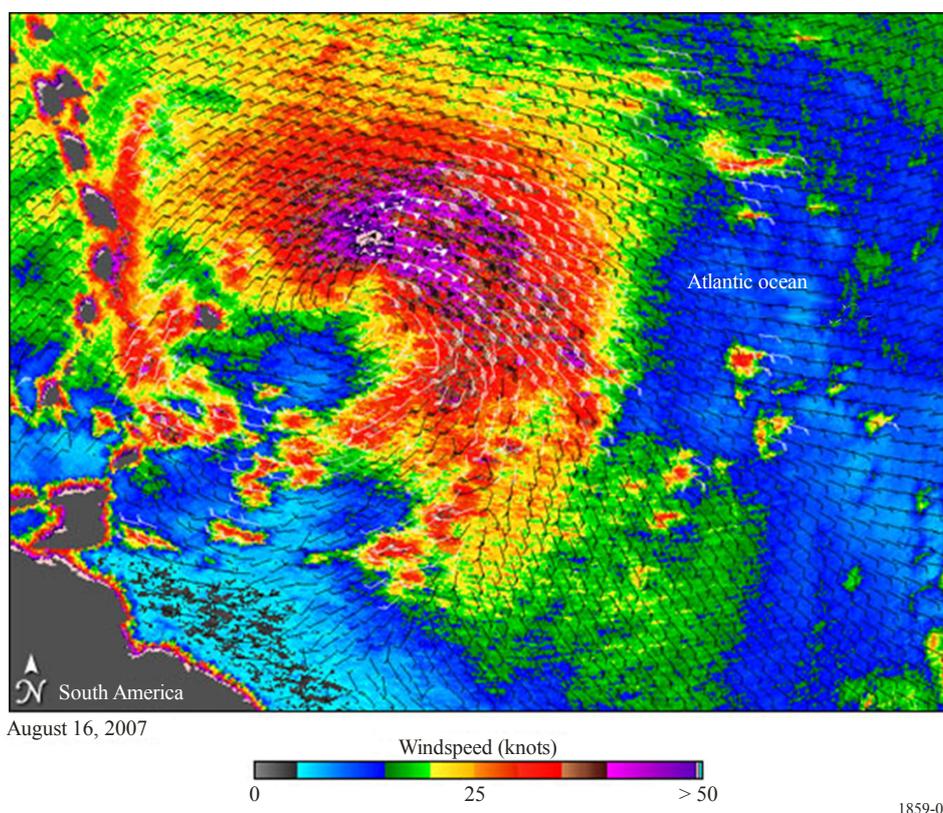
Source: Imager on GOES via NOAA

<http://www.nvvl.noaa.gov/cgi-bin/index.cgi?page=products&category=Year%202007%20Storm%20Events&event=Hurricane%20Dean>

More detailed weather conditions can be observed using radar scatterometer techniques. Figure 7 shows a QuikScat observation of Hurricane Dean revealing the sea surface wind speed and direction. QuikScat was a low Earth orbiting spacecraft and could not provide the continuous coverage afforded by the GOES observations.

The combination of data from these and other satellites help provide a better understanding of the nature of each hurricane and help predict where, when, and how strong the hurricane will be in the near future.

FIGURE 7
QuikScat observation of Hurricane Dean



Source: Scatterometer on QuikScat

<http://www.nasaimages.org/luna/servlet/detail/nasaNAS~10~10~74747~180271:Hurricane-Dean>

Modern weather forecast centres provide higher quality forecasts than were available in the past and constitute another source of extremely useful data. A partial list of such centres includes:

- 1 European Centre for Medium-Range Weather Forecasts <http://www.ecmwf.int/>
- 2 Italian Meteorological Service <http://www.meteoam.it/>
- 3 National Center for Environmental Prediction <http://www.ncep.noaa.gov/>

The World Meteorological Organization (WMO, at <http://www.wmo.int/>) coordinates the distribution, format, and organization of such data worldwide.

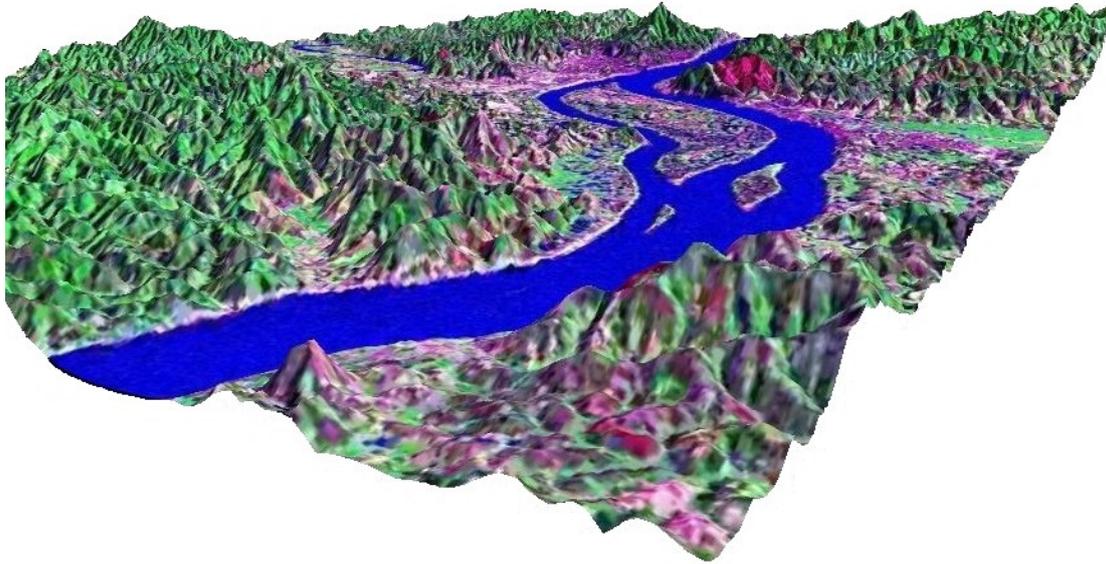
<http://www.ncep.noaa.gov/>

6 Floods

Long before a flood occurs, the areas vulnerable to being flooded (areas at risk) can be identified with the help of satellite-derived DEMs. These DEMs enable the topology of remote low-lying areas to be mapped. Land-use maps help quantify the risk by identifying populated areas. Attention can then be focused on identifying the infrastructure (roads, bridges, communications, etc.) needed to help when a flood occurs (see Fig. 8) and on planning appropriate evacuation strategies.

FIGURE 8

A Landsat image, circa 2000, draped over a SRTM DEM of the city of Wuzhou in the province of Guangxi in China (populated areas appear as reddish-purple)



1859-08

Sources: Landsat-7 data via <https://zulu.ssc.nasa.gov/mrsid/>
SRTM data via <http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp>

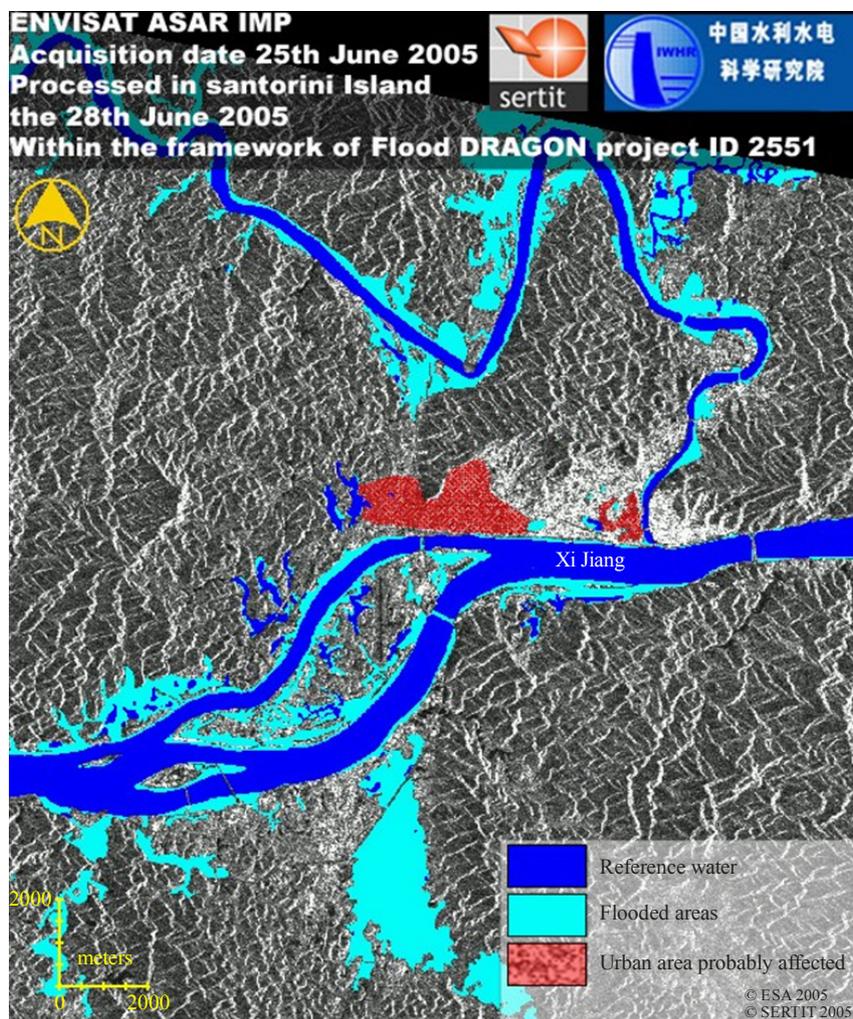
Weather monitoring and weather forecasts can provide warnings that floods are possible or imminent. Supporting data products include areal precipitation, water equivalent from snowfall, and soil moisture, which, in combination, indicate whether the ground will absorb more rain or is saturated.

During a flood event, imagery from multispectral and/or panchromatic imagers and synthetic aperture radars can help guide rescue workers to the specific areas affected and help assess the overall damage. The ability of SARs to penetrate clouds and provide all-weather capability is particularly useful during the flood-producing storm. An example of the ability of SARs to define the areas flooded is given in Fig. 9.

FIGURE 9

Flooding of the Xi River, affecting the city of Wuzhou in Guangxi Province

Reference data are from Landsat; flood data are from ASAR on Envisat



1859-09

Source: ASAR on ENVISAT

http://www.esa.int/esaEO/SEM8MD808BE_index_1.html#subhead1

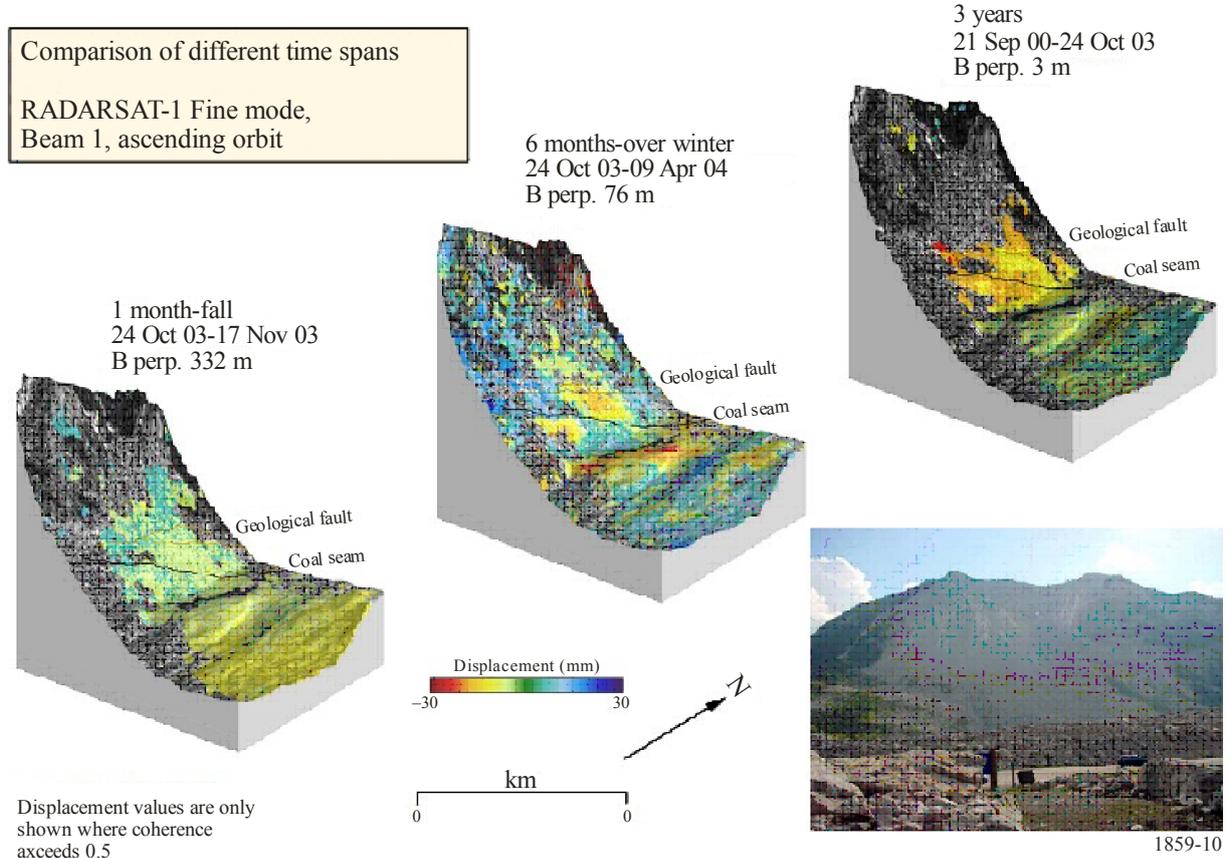
7 Landslides/subsidence/avalanches

Areas vulnerable to landslide activity can be identified using DEMs from SAR measurements. In this case, the slopes rather than the elevations are used. When subtle ground movement is suspected, InSAR and *in situ* GNSS units can provide accurate measurements.

What is left of Turtle Mountain, Canada after the largest landslide in history in North America is still a threat. Its ground movement, shown in Fig. 10, is being monitored by Canada's RADARSAT-1 using the InSAR technique.

FIGURE 10
RADARSAT InSAR tracks ground displacement between 2000-2004

Franck Slide, Alberta-Trans Canada highway
 Monitoring slope stability from SAR interferometry



Source: RADARSAT via CSA

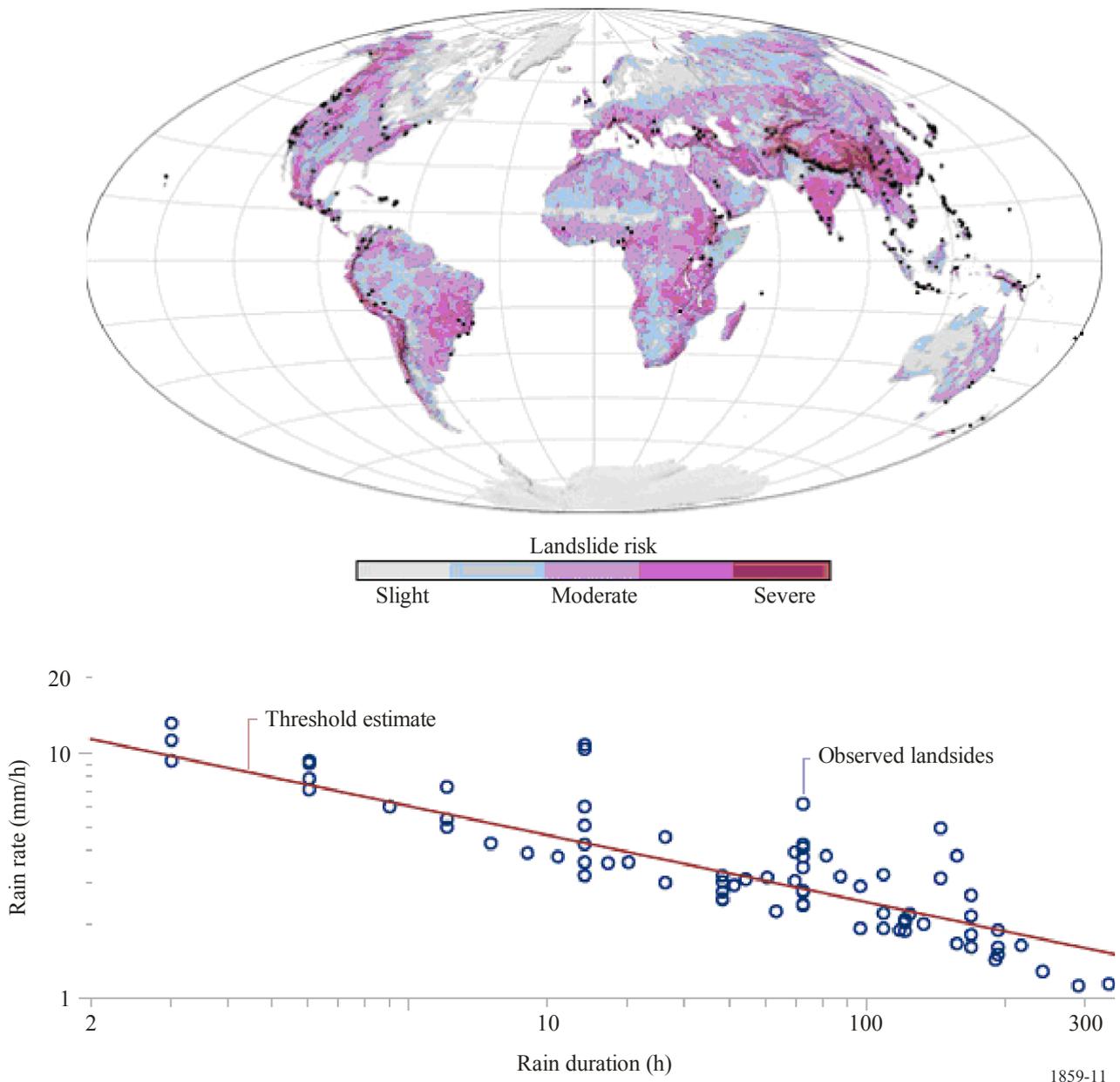
<http://www.isprs.org/publications/related/ISRSE/html/papers/759.pdf>

Changes in land cover or land usage can increase the risk of landslides. For example, a heavily logged (deforested) area is far more susceptible to landslides than an area with an established ecosystem that stabilizes the ground. Land-use maps help quantify the risk by identifying populated areas that may be vulnerable. Land cover/land usage can be monitored from space and changes detected to aid in monitoring the risk.

When soil on steep hillsides becomes saturated with water during a very heavy rainfall, it becomes vulnerable to producing landslides. Thus, forecasts of heavy rainfall coupled with knowledge of the pre-rainfall soil moisture, can provide warnings that landslides may occur.

Satellite data can be used to provide maps indicating the risk of landslides (see Fig. 11). Data shown on Fig. 11 were derived from topography from SRTM, land cover/usage from MODIS, and rainfall from TRMM.

FIGURE 11
 Satellite-derived landslide risk map. Black dots indicate landslides reported from 2003 through 2006



Source: SRTM, MODIS, and TRMM via NASA
<http://earthobservatory.nasa.gov/Features/LandslideWarning/>

After a landslide has occurred, InSAR images can provide an accurate mapping of the ground movement (subsidence) by comparing before and after SAR imagery of the bare Earth. Other imagery can show the areas affected by the impact on the vegetation and other surface features.

The magnitude 7.6 earthquake that shattered Pakistan on 8 October 2005, caused the most damage in the region surrounding the city of Muzaffarabad, about 10 km southwest of the earthquake’s epicentre. The quake flattened buildings and triggered landslides throughout Kashmir. The Ikonos satellite captured an image of a landslide (Fig. 12, right) in Makhri, a village on the northern outskirts of Muzaffarabad, on 9 October 2005. The western face of the mountain has collapsed, sending a cascade of white-grey rock into the Neelum River.

FIGURE 12

Satellite imagery showing effects of Neelum River Landslide of 8 October 2005 following an earthquake in Pakistan



Source: IKONOS via NASA

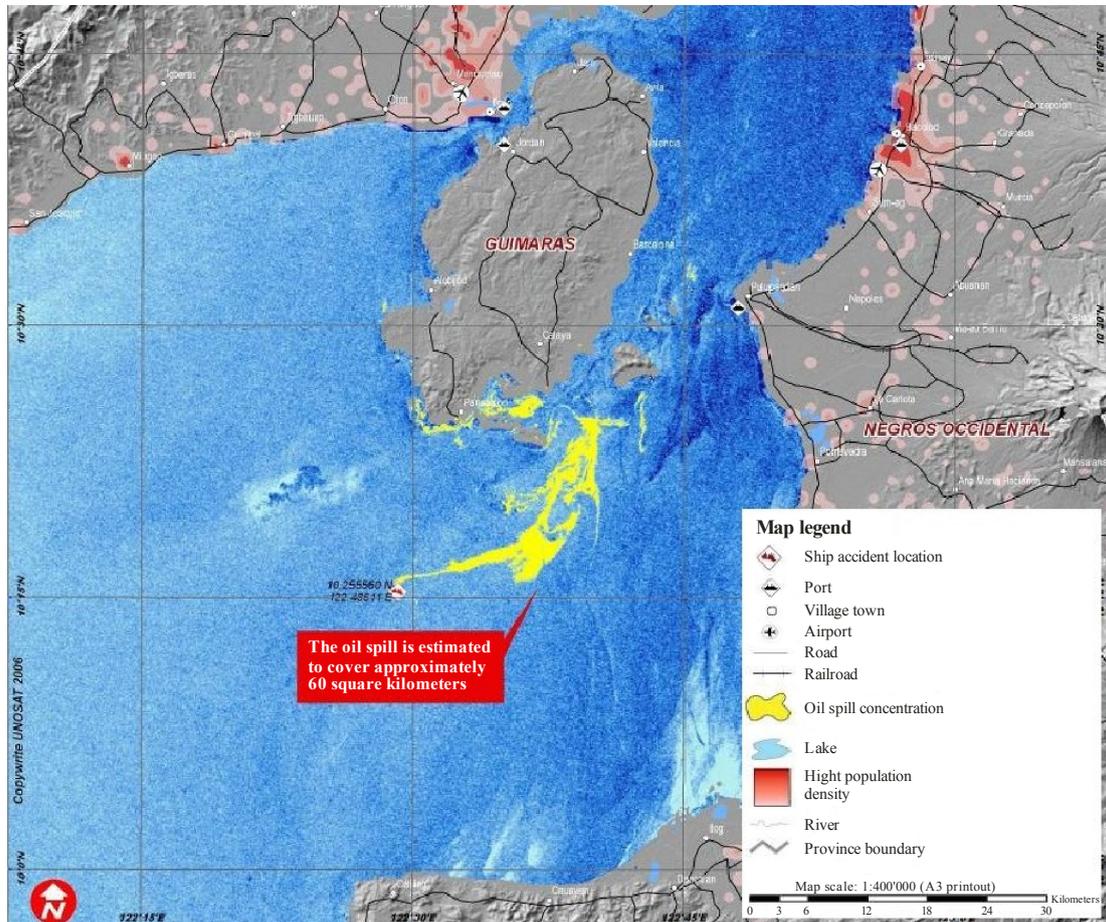
<http://earthobservatory.nasa.gov/IOTD/view.php?id=5952>

8 Oceanic pollution

Oceanic oil spills can be detected using SAR imagery. Operationally, oceanic oil spill detections are treated as preliminary observations and are immediately confirmed via seaborne, *in situ* measurements. This technique allows large areas to be monitored at lower cost. After an oil spill is confirmed *in situ*, the area affected can be monitored and tracked by satellite.

On 11 August 2006, the oil tanker Solar sank off the coast of Guimaras Island in the Philippines. By 24 August 2006, some 50 000 gallons of oil had leaked into the sea, polluting more than 300 km of coastline and threatening fishing as well as other islands of the Philippines. The SAR on the ENVISAT satellite was used to derive the image in Fig. 13. It shows the exact location and the extension of the oil slick on 24 August 2006.

FIGURE 13
Oil spill near Guimaras Island, Philippines: Synthetic aperture radar image



1859-13

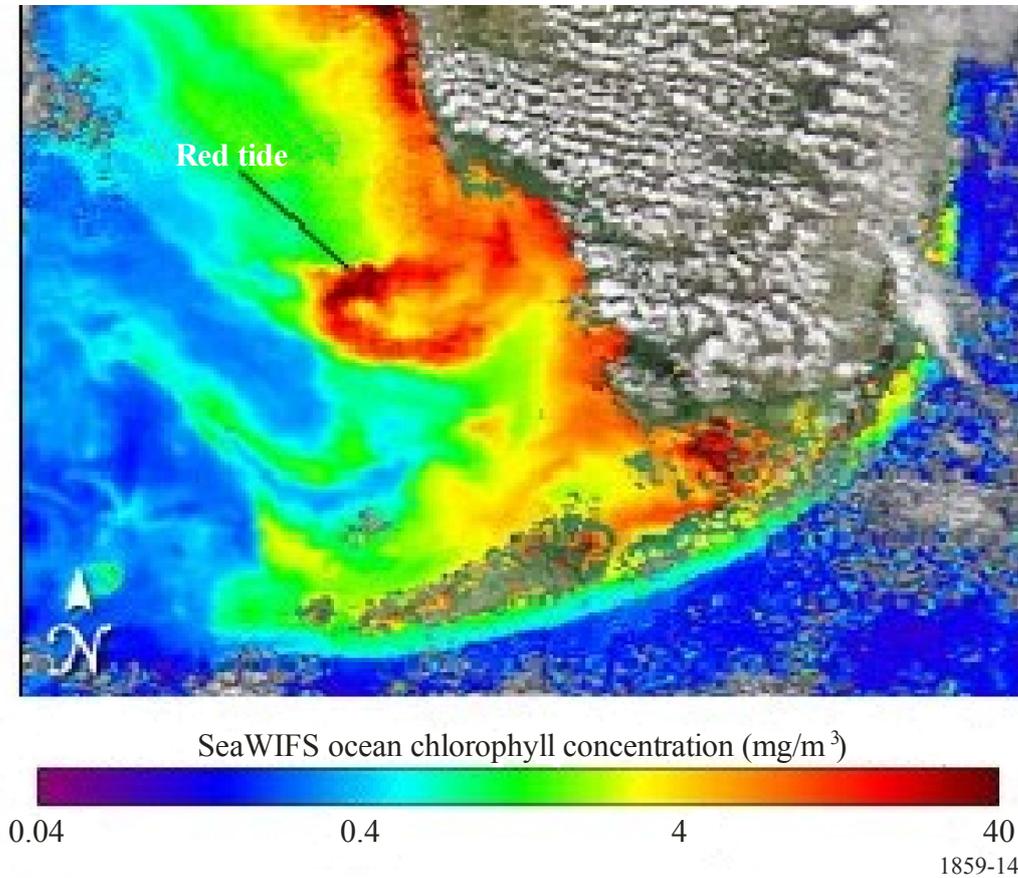
Source: ASAR on ENVISAT via UNOSAT

http://www.unosat.org/freeproducts/philippines/UNOSAT_philippines_oilspill_24aug06_v1.1_highres.jpeg

Natural oceanic pollution in the form of a “red tide” (a common name for an algal bloom, associated with the production of natural toxins, depletion of dissolved oxygen or other harmful conditions) can be detected and monitored from space by observing ocean colour. Identifying and quarantining areas afflicted by a red tide protects human health. Other pollution forms (e.g. water pollutants, coastal sediments) can be detected using satellite images in the visible and/or infrared spectrum (see Fig. 14).

FIGURE 14

Red tide observed with the SeaWiFS instrument 21 November 2004 of Florida
in the south-eastern corner of the United States of America



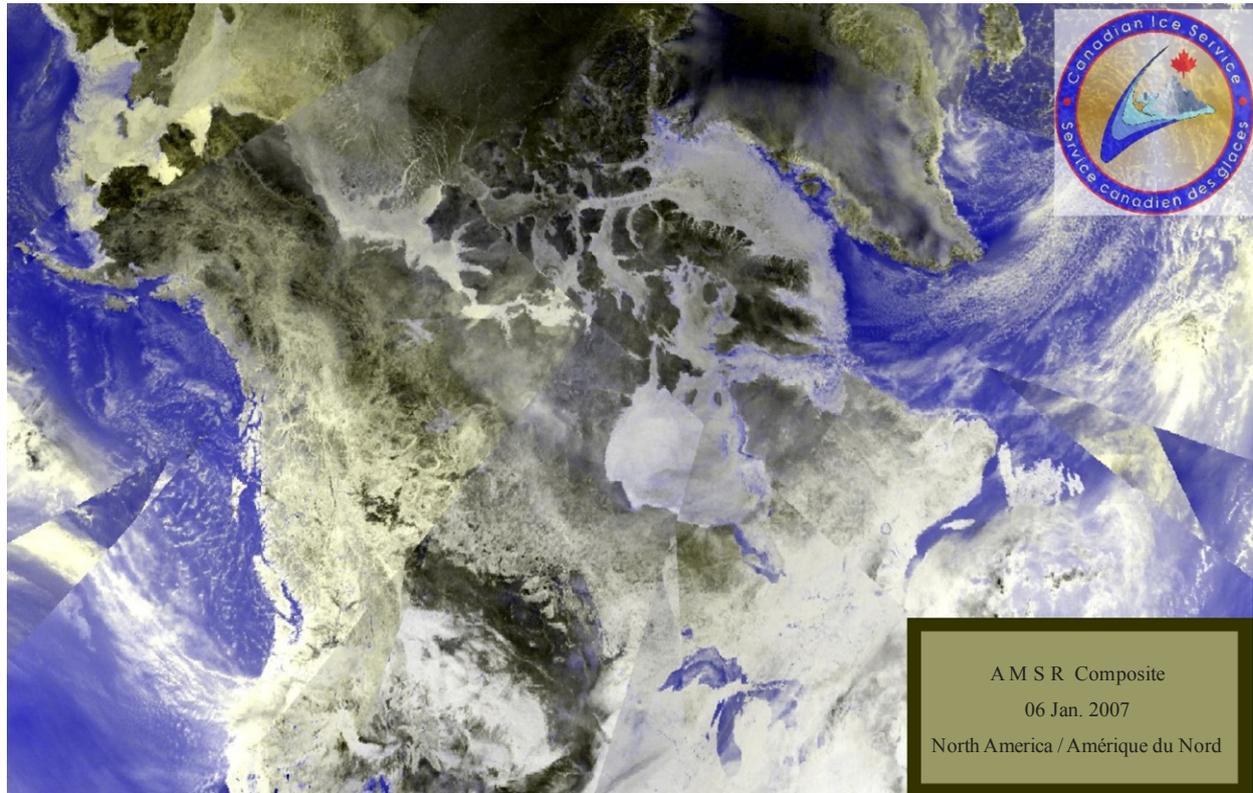
Source: SeaWiFS on SeaStar

http://visibleearth.nasa.gov/view_rec.php?id=19719

9 Sea and lake ice

Satellite-borne passive microwave sensors (Fig. 15) have mapped sea ice extent for decades, and SARs (Fig. 16) are used operationally to guide Arctic and high latitude lake shipping and to extend the shipping season at high latitudes.

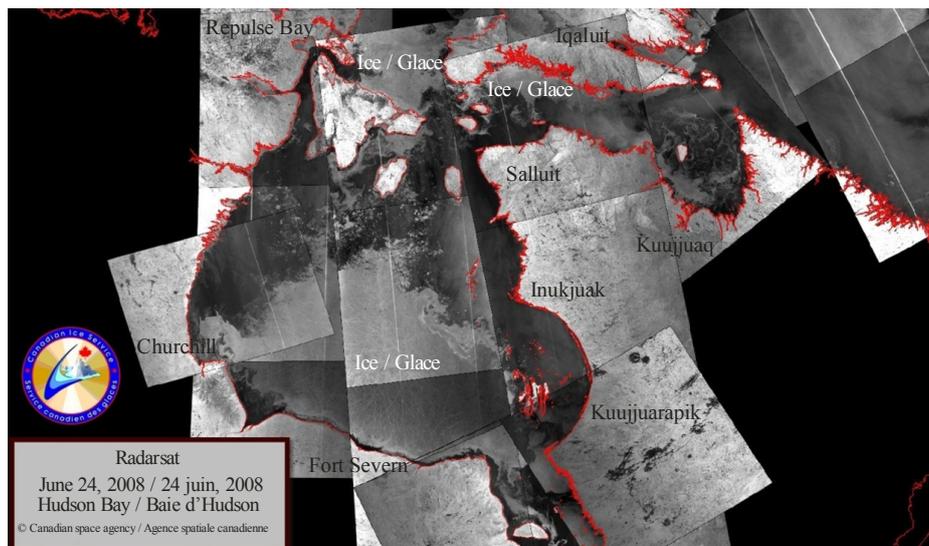
FIGURE 15
Ice over North America in January 2007 (Hudson's Bay blocked)



1859-15

Source: AMSR via Canadian Ice Service
http://ice-glaces.ec.gc.ca/content_contenu/images/AMSR_image_Jan_06_2007.jpg

FIGURE 16
Ice in Hudson's Bay, Canada in June 2008 (open water along the eastern shore)



1859-16

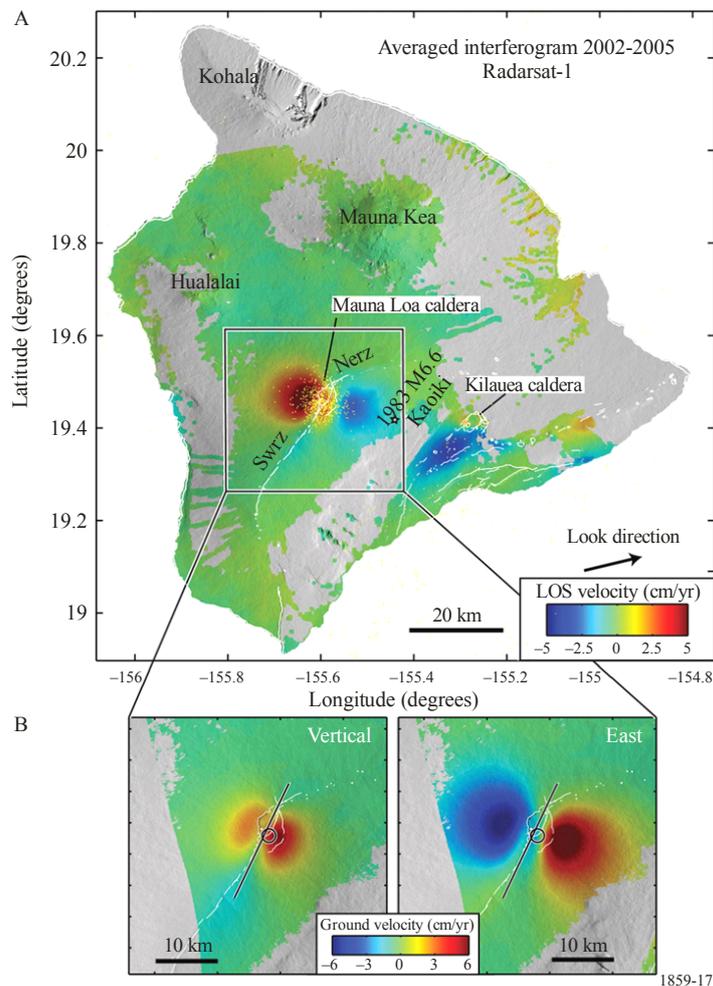
Source: RADARSAT via Canadian Ice Service
http://ice-glaces.ec.gc.ca/content_contenu/images/Radarsat_June_24_2008.JPG

10 Volcanoes

Since volcanic activity is frequently preceded by swelling/uplifting of the ground in the immediate area, potential volcanic activity can be monitored, to some degree, by mapping such ground movements. *In situ* GNSS units can provide local monitoring while InSAR observations can provide less timely measurements at remote locations. An InSAR image of the Hawaiian volcano Mauna Loa (Fig. 17) shows long-term change in the surface, indicating swelling which is indicative of subterranean volcanic activity. Such subtle ground motions can be used to identify potential volcanic hazards anywhere in the world.

FIGURE 17

Interferometric SAR image of the Mauna Loa Caldera in Hawaii Ground motion indicates dangerous underground volcanic activity

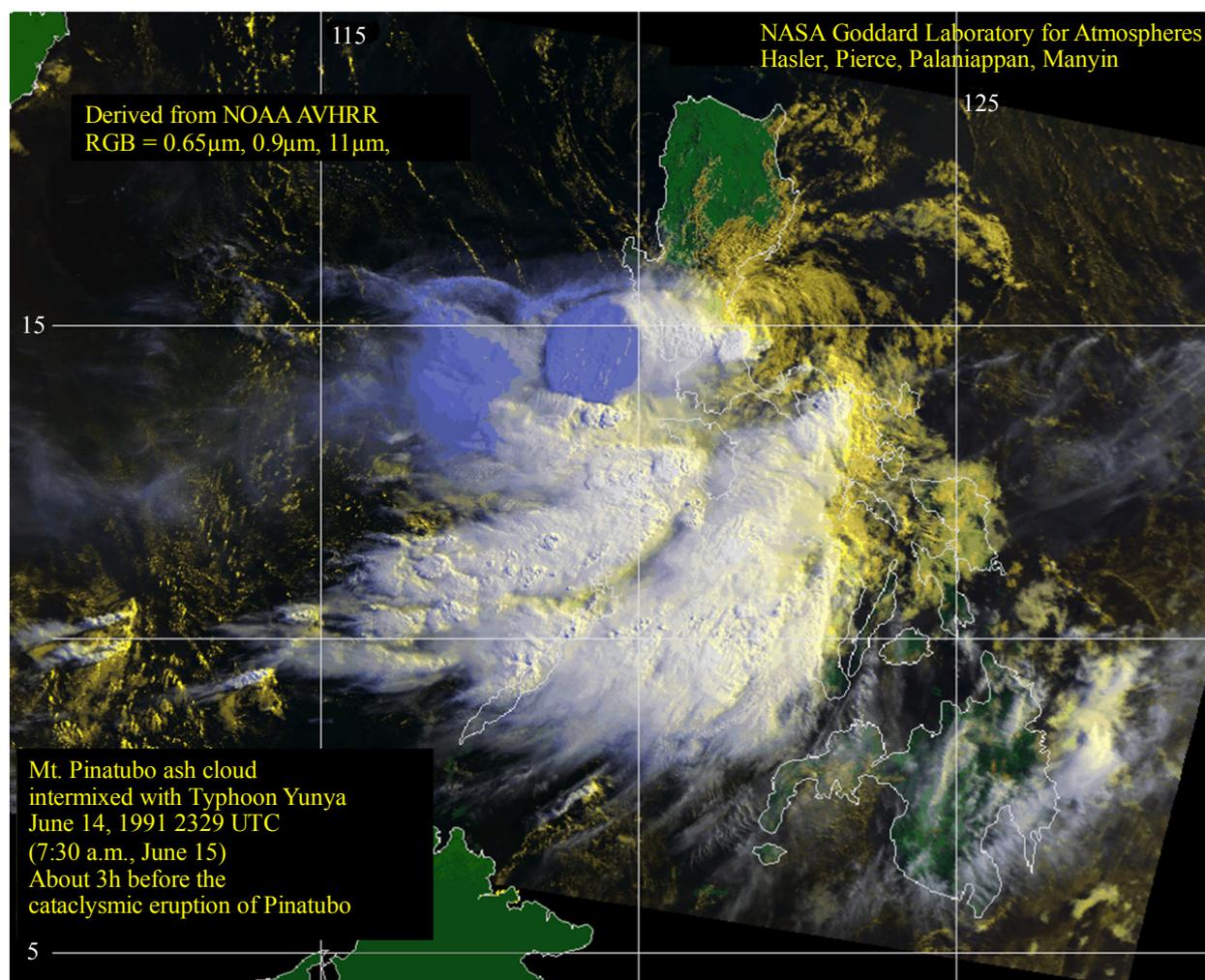


Source: RADARSAT (Canadian Space Agency) via the Alaska Satellite Facility
<http://www.sciencemag.org/cgi/content/full/316/5827/1026>

During and after an eruption, the thermal signature of the lava, ash, and hot gases are routinely tracked using infrared and visual observations from space. In particular, the volcanic ash in the atmosphere poses serious hazards to aircraft in flight.

FIGURE 18

**Mount Pinatubo ash cloud intermixed with Typhoon Yunya
3 h before the 15 June 1991 eruption**



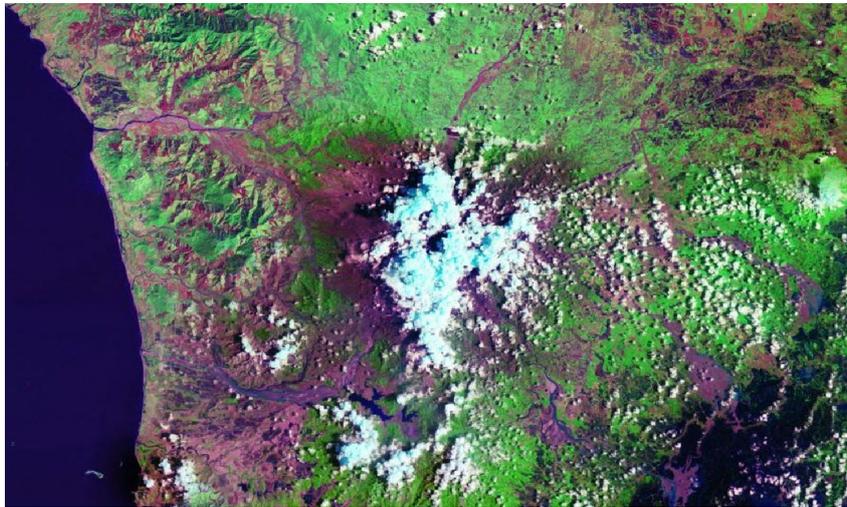
Source: NOAA AVHRR via NASA

<http://rsd.gsfc.nasa.gov/rsd/images/Pinatubo.html>

Imaging from satellites supports the identification of impacted areas and the monitoring of recovery. Images from visible and infrared wavelengths support the monitoring of vegetative recovery (see Figs 19 and 21). In areas where cloud cover poses a problem, SAR images provide another source of information (see Fig. 20). The following sequence of images follow the aftermath of the Pinatubo volcano eruption in the Philippines which occurred on 15 June 1991.

FIGURE 19

Landsat 5-9 September 1991. Damaged vegetation is red-brown



1859-19

Source: Landsat 5 data via <https://zulu.ssc.nasa.gov/mrsid/>

FIGURE 20

Landsat 5 overlaid with SIR-C – Oct. 1994. No cloud problem, terrain is visible, and lahars (mud flows) are distinct and easily recognized

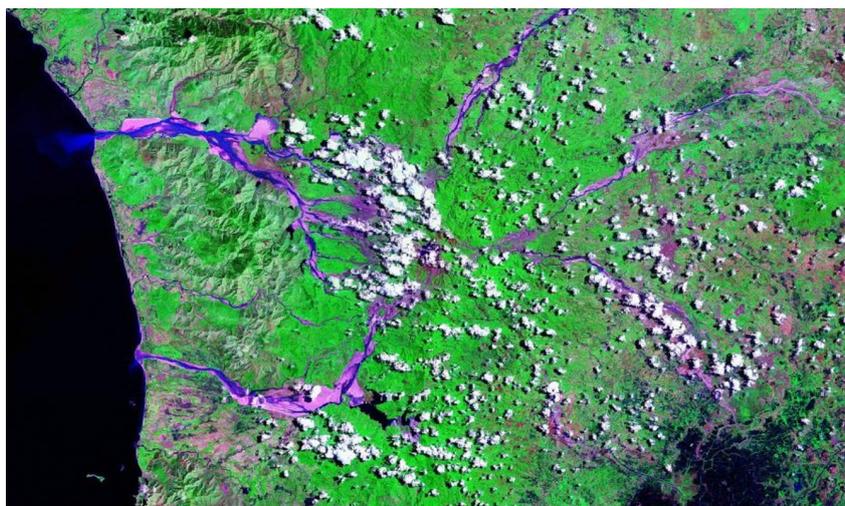


1859-20

Sources: Landsat 5 data via <https://zulu.ssc.nasa.gov/mrsid/> sir-c/x-sar data via <http://geoinfo.amu.edu.pl/wpk/jpl/pinatubo2.html>

FIGURE 21

Landsat 7-18 May 2001. Vegetation recovered



1859-21

Source: Landsat 7 data via <https://zulu.ssc.nasa.gov/mrsid/>

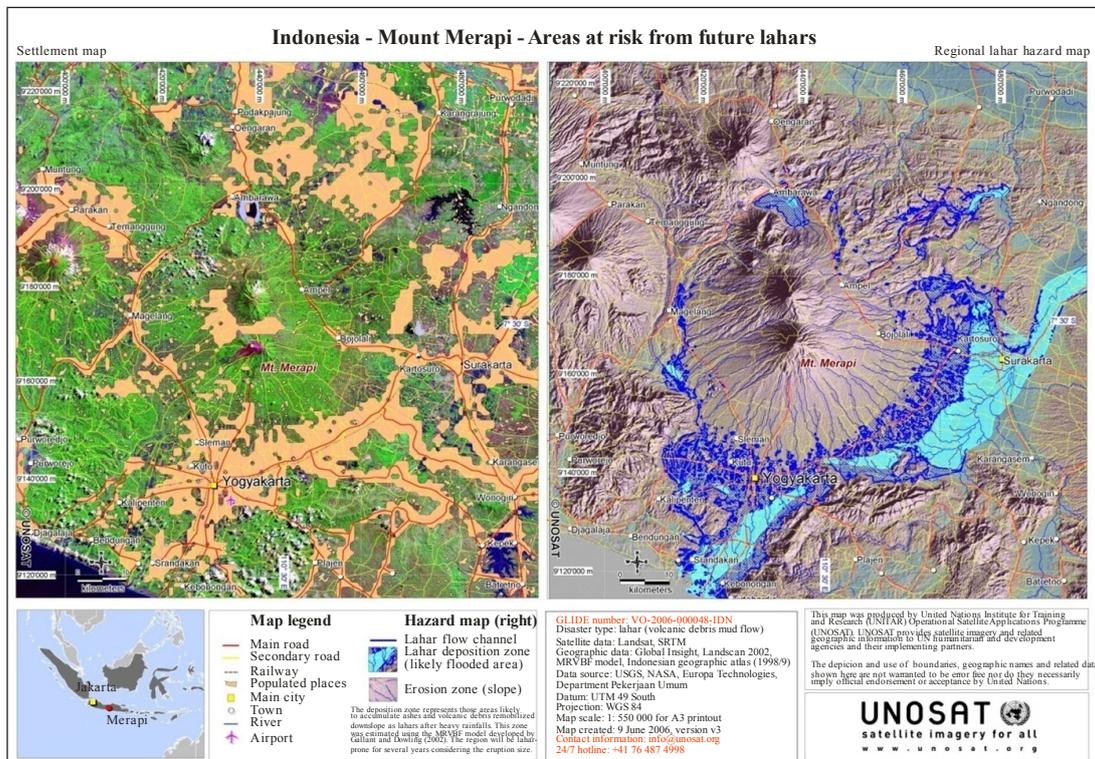
SAR imagery is also useful in identifying areas at risk. The Pinatubo eruption produced several “lahars”, or mud flows. These lahars are easily identified in SAR images (Fig. 20), and could be re-activated by heavy rains. One such occasion occurred in 1994 and was observed by the Shuttle Imaging Radar. Nearby inhabited areas were placed at risk.

Digital elevation models (DEMs) have proven useful in predicting where such lahars may occur. The lahars follow the gulleys and flow into low areas.

Such DEMs can be combined with land use/land cover maps, such as derived from Landsat or MODIS, to map areas at risk. An example of such a risk map is shown in Fig. 22.

FIGURE 22

Landsat and SRTM combine to identify vulnerable areas and populations



1859-22

Source: Landsat and SRTM via UNOSAT

http://unosat.web.cern.ch/unosat/freeproducts/indonesia/UNOSAT_Merapi_areas_at_risk_lahars_v3_lowres.jpg

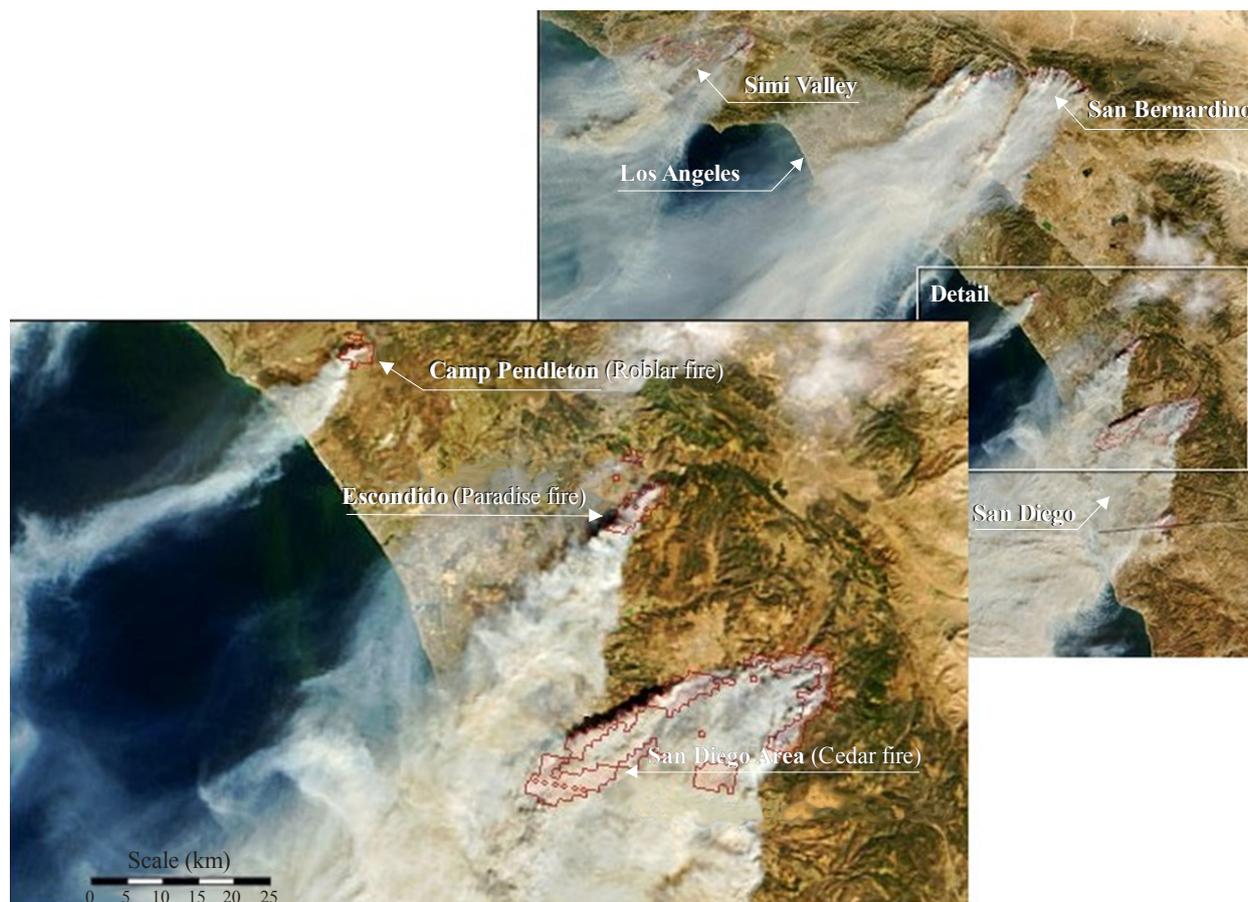
On the left image, NASA-constructed, USGS-operated, Landsat: used to identify urban areas as contrasted with agricultural fields. On the right image, topographic data from NASA's Shuttle Radar Topographic Mission was used to identify the areas that would likely be buried under mud. The combination of the two maps gives the local authorities a tool to plan actions to take in the event of an eruption of Mount Merapi in the future.

11 Wildland fires

The risk for wildland fires in remote, sparsely populated areas can be estimated from space measurements of soil moisture and vegetative state (i.e. is the vegetation healthy or distressed/parched?). Wildland fires can be detected using certain infrared channels being flown on spaceborne instruments. These channels effectively penetrate the smoke and haze which obscure visible-wavelength observations. To reduce the time separation between the satellite observation and the generation of needed data products, several agencies, governments, and non-governmental organizations worldwide have installed ground stations to receive real-time data every time an appropriate satellite passes overhead.

These images are useful in combating wildfires. Southern California in the United States is prone to wildfire outbreaks during its dry season (see Fig. 23). These fires are enhanced by the local Santa Ana winds, which make fighting them difficult. Satellite imagery helps guide fire fighters and is particularly useful in remote, unpopulated areas.

FIGURE 23
Fires in Southern California, 26 October 2003



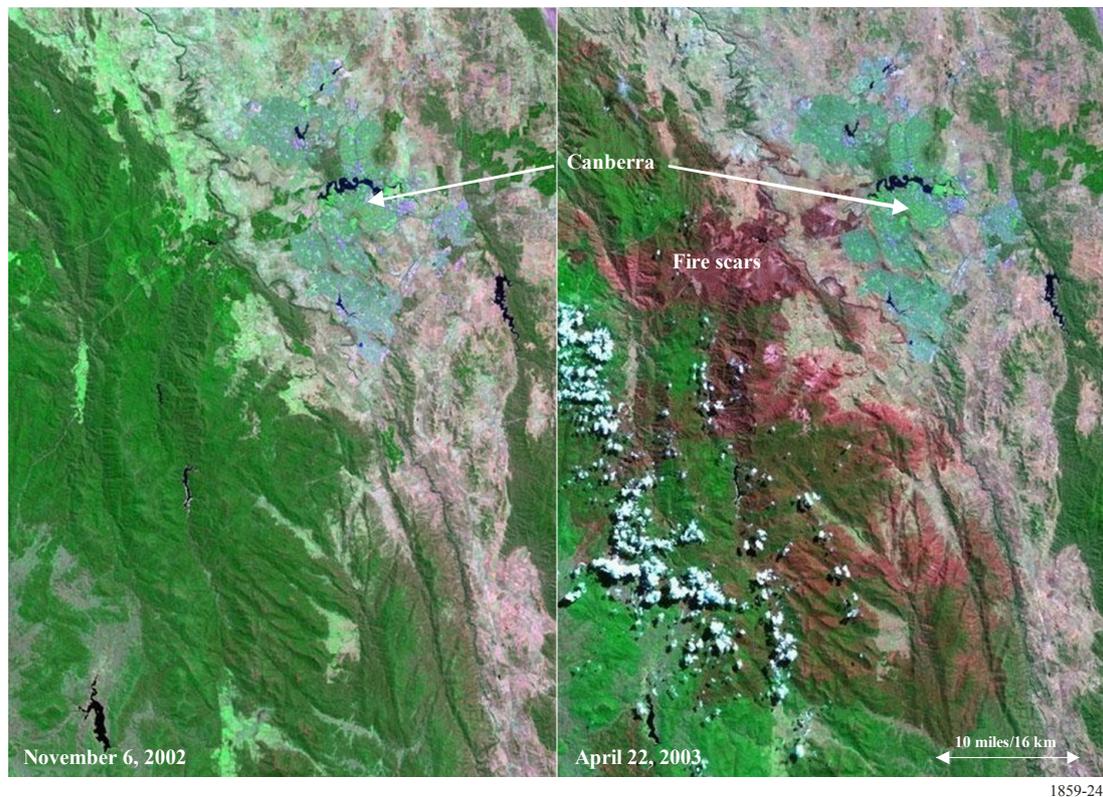
1859-23

Source: MODIS instrument on TERRA via NASA
<http://www.geotimes.org/oct03/WebExtra103103.html>

After a fire has been extinguished, satellite visible and infrared imagery and SAR imagery can be used to determine the extent of the damage and to monitor the recovery of the vegetation.

Wildfires were rampant in the Australian summer of 2002-2003, with over 50 separate fires in the southeast portion of the continent. The capital city of Canberra was threatened by a bush fire that began on 18 January in the Namadgi National Park. Within a few days, the fires had spread to the outskirts of the city, forcing thousands of people to evacuate the city and prompting thousands more to volunteer as fire fighters to protect Canberra from the flames. By the time the fire was under control, four people had died and 419 homes had been destroyed. In the Landsat 7 images below (Fig. 24), healthy vegetation appears green while burned regions appear in varying shades of red.

FIGURE 24
 Before and after Landsat images of Canberra, Australia during the fires of 2002-2003



Source: Landsat 7

http://landsat.usgs.gov/gallery_view.php?category=orangeflag&thesort=mainTitle

12 Remote sensor database

As a result of studies compiled in the ITU-D, a “Disaster Support Summary” has been prepared to provide a survey of terrestrial and space-based active and passive sensor applications for disaster support. This summary database is in the form of a spreadsheet accessible through the Internet at: <https://www.sfcgonline.org/rs-benefits>

13 Summary

To use the data collected by remote sensing systems and other sources, a single point of contact for summoning international disaster support using space resources has been established following the UNISPACE III conference held in Vienna, Austria in July 1999. An authorized user can now call a single number, supported 24 hours a day, to request the mobilization of the space and associated ground resources (*RADARSAT*, *ERS*, *ENVISAT*, *SPOT*, *IRS*, *SAC-C*, *NOAA-series*, *LANDSAT*, *ALOS*, *DMC* satellites and others) of the member agencies to obtain data and information on a disaster occurrence. Examples of data provided can be found at: http://www.disasterscharter.org/new_e.html.

Any questions or comments for the Charter members or about the website should be directed to: webmaster@disasterscharter.org.

Another source of remote sensing data is UNOSAT, a United Nations programme created to provide the international community and developing nations with enhanced access to satellite imagery and geographic information systems services. These tools are used mainly for humanitarian relief, disaster prevention, and post-crisis reconstruction. The services provided include satellite imagery selection and procurement assistance, image processing, map production, methodological guidance, technical assistance, and training. Their Internet site is: <http://unosat.web.cern.ch/unosat>.

A third source of remote sensing support is SERVIR, the regional visualization and monitoring system, which can be found at: <http://www.servir.net>.

The SERVIR initiative integrates satellite observations, ground-based data and forecast models to monitor and forecast environmental changes and to improve response to natural disasters. SERVIR enables scientists, educators, project managers and policy implementers to better respond to a range of issues including disaster management, agricultural development, biodiversity conservation and climate change. Endorsed by governments of Central America and Africa and principally supported by NASA and the US Agency of International Development (USAID), a strong emphasis is placed on partnerships to fortify the availability of searchable and viewable Earth observations, measurements, animations, and analysis. A SERVIR coordination office and rapid prototyping facility is located at the NASA Marshall Space Flight Center in Huntsville, Alabama. Regional SERVIR nodes are located at the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) in Panama and the Regional Center for Mapping of Resources for Development (RCMRD) based in Kenya. Contacts for SERVIR are:

SERVIR Director: Daniel.Irwin@nasa.gov
SERVIR Mesoamerica: Emilio.Sempris@cathalac.org
SERVIR Africa: Kate.Lance@nasa.gov

NOTE 1 – It would be advisable for parties with potential, or probable, need to seek help from any or all of the above agencies to contact them in advance of any disaster and to establish a procedure (e.g. assign liaison personnel with names, e-mail addresses, telephone numbers, etc.) for obtaining help should a disaster occur. Such advance planning would significantly shorten the time required to get help when it is needed.
