

## Information series on geographical information and remote sensing systems in mountain environments

Geographical information and remote sensing systems play a special role in the Hindu Kush-Himalayan region in support of informed decision making. This series of information sheets presents information on basic technologies, approaches, and applications related to geographical information and remote sensing, and used or developed by ICIMOD, as a background for understanding for policy makers, development workers, and others.

The number of natural disasters is increasing, with an attendant rise in human and civic emergencies. In 2010, more than 250,000 people died in natural disasters globally, making it one of the deadliest years in more than a generation. Timely information on rapidly evolving events is needed more than ever before to help in planning of emergency response. This need has led to an increasing demand for access to comprehensive, near real-time, earth observation data covering wide areas to provide information on a broad spectrum of civilian crises.

# Space-based information and rapid mapping for Emergency Response

The Hindu Kush-Himalayan region is one of the world's most complex, dynamic, and intensive hotspots in terms of risk from natural hazards including earthquakes, floods, landslides, droughts, and wildfires. It is a region of fragile ecosystems that are very sensitive to changes in climatic conditions and exceptionally vulnerable to natural hazards. Examples of recent disasters in the region include the earthquake in Sichuan, China; cyclone Nargis in Myanmar; the outbreak of the Koshi barrage embankment in Nepal; and the 2010 floods in Pakistan. They all serve to remind us of the devastating and catastrophic effects natural hazards can have on our lives.

Earth observation data facilitate the monitoring of an event as a disaster unfolds and can provide vital information and services for disaster management. Earth observation satellites provide comprehensive and multi-temporal coverage of large areas in real time and at frequent intervals which can be used for detailed monitoring, damage assessment, and long-term relief management. However, a system is needed to provide rapid access to earth observation data in a usable form to those on the ground who need them in an emergency.

**Above:** QuickBird satellite image of a flooded area in Pakistan, 29 August 2010

## ICIMOD Approach

ICIMOD is helping the countries of the Hindu Kush-Himalayas to access remote sensing data in a disaster through the Sentinel Asia initiative, which in turn can call upon the members of the International Disaster Charter for emergencies of international significance.

## Sentinel Asia

Sentinel Asia is a voluntary initiative led by the APRSAF (Asia-Pacific Regional Space Agency Forum) to support disaster management in the Asia-Pacific region using web-GIS technology and space-based technology such as earth observation satellite data. Currently, five countries – Japan, India, Thailand, Taiwan, and Korea – are providing earth observation data to Sentinel Asia members during major disasters. In the Hindu Kush-Himalayan area, Internet services are limited and access to satellite data can be difficult. Sentinel Asia uses local mirroring and transfers data from the Japan Central Server to users' local mirrored servers, not only via the Internet but also using the communications satellite JAXA WINDS (wide-band Internetworking engineering test and demonstration satellites 'KIZUNA'). A WINDS receiving station was set up at ICIMOD in October 2010. The WINDS system can transmit at 1.55 Megabytes per second; by using the WINDS satellite, the Sentinel Asia Step 2 system can transfer large amounts of data that would be difficult to transmit via Internet.

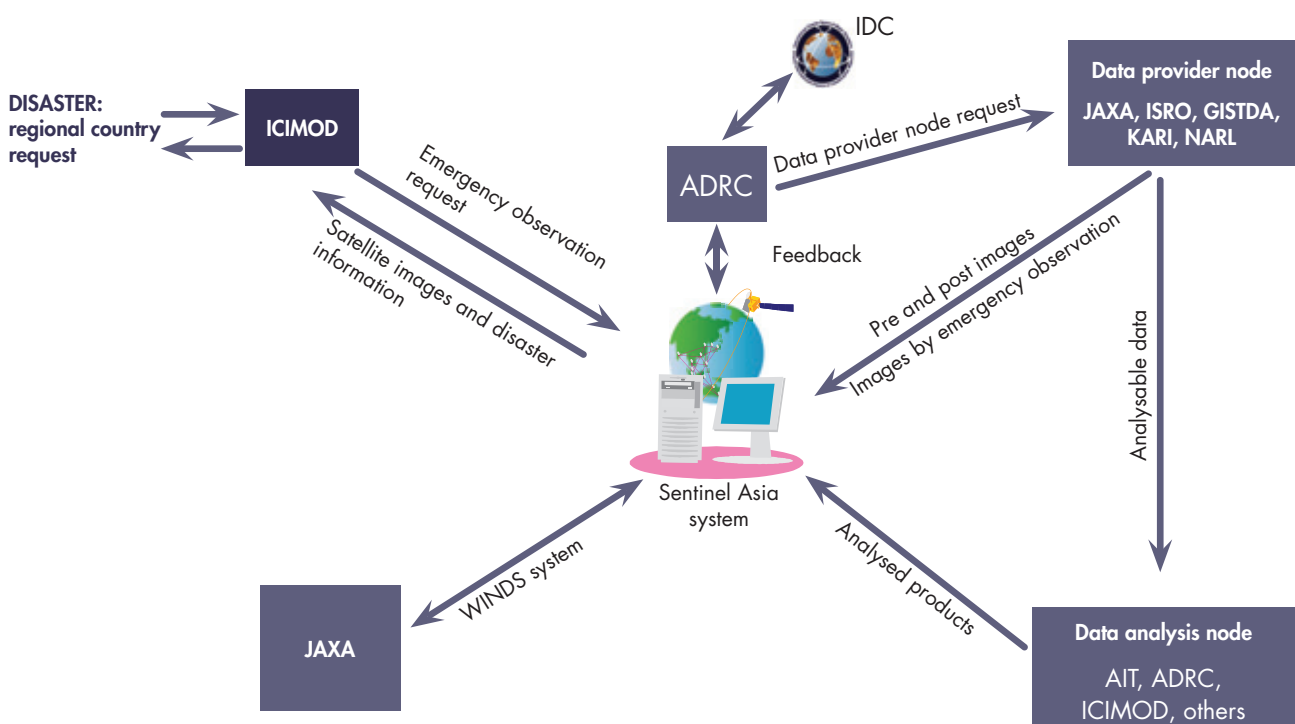
When an ICIMOD member country asks for support in an emergency situation, ICIMOD sends a request to the

## The International Disaster Charter

In 1999, as a result of Hurricane Mitch in Central America, the International Charter 'Space and Major Disasters' was initiated to provide aid workers with satellite data over affected areas. The International Disaster Charter (IDC) provides a unified system of space data acquisition and delivery to those affected by natural or man-made disasters. The Charter was founded by ESA and the French space agency, CNES, and began operating formally in October 2000. The Charter supports relief efforts and allows registered users, usually designated space agencies, to request and access free satellite data over stricken regions. Following activation, all available satellites are tasked to acquire data over the requested area. The raw data are processed and interpreted and made directly available to the civil protection agencies concerned. As of October 2010, the Charter had 11 members and three agencies in the process of joining, and had provided satellite data for more than 300 disaster events – including earthquakes, hurricanes, cyclones, floods, and fires – spanning nearly 100 countries.

Sentinel Asia system, which provides the appropriate products through the JAXA receiving system. ICIMOD then processes these data, for example through 'rapid mapping', and forwards the resultant products to the country concerned. Where appropriate, Sentinel Asia will activate the International Charter to access data from providers outside the region. The system is summarised in the figure.

Accessing data for regional countries during a disaster using the Sentinel Asia system



## Rapid Mapping for Satellite-generated Crisis Information

In general it is more important after a disaster to have a rapid overview of the damage than to have a detailed assessment; information is needed within hours (or up to a few days for large areas). The best images for this are those with lower resolution from satellites that pass over the area many times within a short period (e.g., MODIS, NOAA, and GOES). Satellite images with moderate to high resolution can be used subsequently for more precise damage estimation for resource allocation (e.g., Landsat, ALOS, ASTER, IKONOS, and QuickBird). During disasters, it can be difficult to obtain cloud-free images and microwave satellite data can play a significant role in detecting and monitoring events (e.g., ALOS Palsar, IRS RISAT, RADARSAT, ENVISAT ASAR).

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**"It is important to use the advantages that space technologies offer to improve life on Earth. The Charter is a beautiful example of this because it delivers very concrete products to users, such as rapid crisis mapping to civil protection agencies and aid workers."**  
ESA Director General Jean-Jacques Dordain

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Maps are generated from the remote sensing data through a series of steps: integration of the spatial data, data analysis, interpretation, layout, quality control, editing, and revision. The final maps showing the required information on the disaster are sent to the users. Layers can be added from existing maps and information showing, for example, the position of affected infrastructure like bridges, health facilities, schools, and housing, that may play a decisive role in approaches to disaster response. Some examples of rapid mapping are given below.

Close contact and interaction with key actors in the user community are as important as the actual data processing and delivery during the cycle from a request for assistance through to providing the map or other product. Crisis teams need to coordinate by linking earth-observation systems, information extraction, and uninterrupted dissemination to trained decision makers and/or field staff of relief organisations. When this is done, space-based crisis mapping can make a large contribution to disaster-relief operations.

Large wildfires broke out across Nepal on 12 March 2009. The MODIS on NASA's Aqua satellite detected numerous fires, many burning in protected areas (above: real image overlaid with red spots showing active fires; below: image showing fire smoke and ignition without cloud)

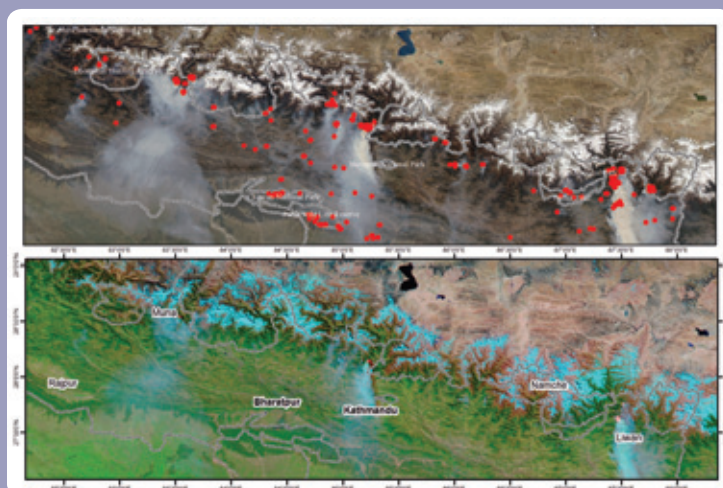
## Examples of Use of Space Data and Rapid Mapping

### Forest fires in Nepal

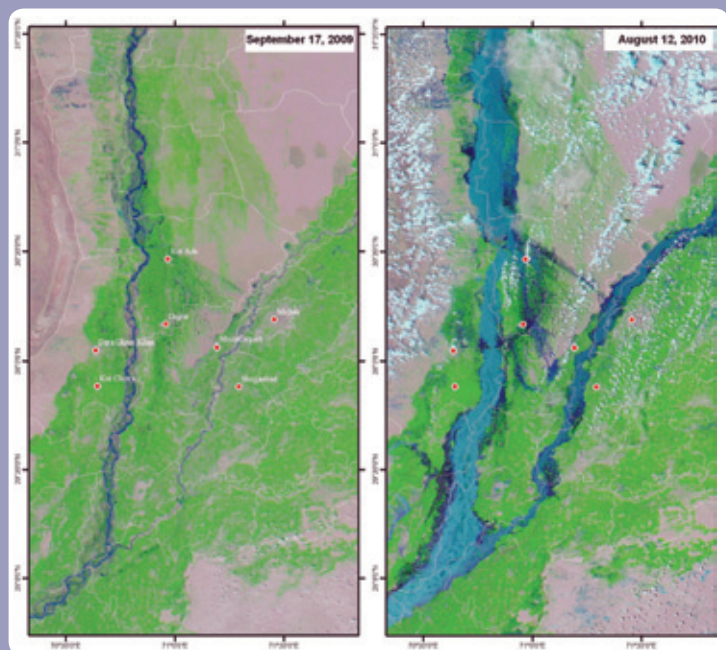
Every summer, natural- and human-induced wildfires threaten the environment and local populations in the Himalayan region. Since 2008, ICIMOD has been identifying fires in southern Nepal during the peak season using MODIS Terra and Aqua satellite data and generating maps on a daily basis to provide value-added products two to three hours after the satellite passes over. The fires identified are probably mainly agricultural or other land-management fires, as well as uncontrolled forest fires. The Centre publishes this information on the ICIMOD Mountain Geoportal. When the fires are large scale, ICIMOD activates the Disaster Charter through Sentinel Asia system for precise mapping.

### Floods in Pakistan

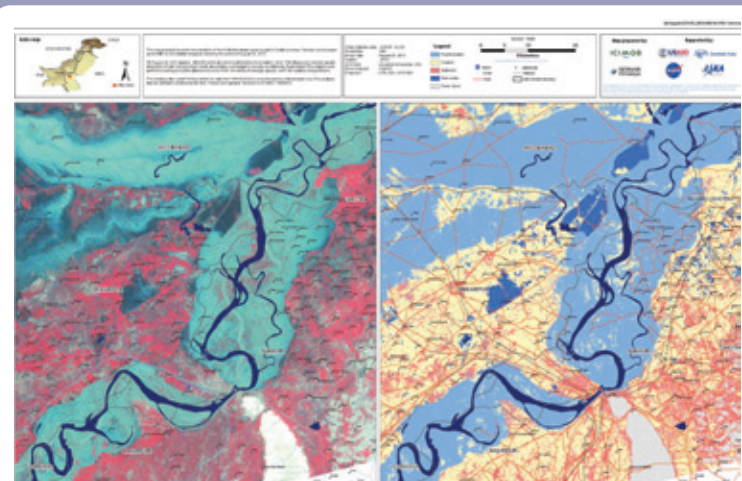
The most devastating floods in human memory in Pakistan began in late July 2010. They directly affected some 20 million people with destruction of property, livelihoods, and infrastructure; the death toll was almost 2,000. ICIMOD made an emergency observation request to Sentinel Asia as a joint project team member of APSRAF. The first post-disaster images were made available one day after the disaster. Due to the scale of the damage, the International Charter helped ICIMOD by providing satellites datasets from outside the Sentinel system. Daily inundation reports depicting flood direction and movement were prepared using MODIS data; Landsat and ALOS AVINIR images were used for damage assessment. The maps, geodatabase, and KML layers were provided to the disaster networks in Pakistan directly and made widely available to the international user community, the press, and the public via the Mountain Geoportal. The maps provided disaster managers with an overview of the situation and enabled them to assess the damage, and supply reliable value-added information to disaster networks at short notice.







Floods in Pakistan: a) left, before and after images captured using MODIS; b) below, JAXA ALOS-AVINIR satellite image from 23 August 2010 showing inundated area (left), and map product from 24 August for damage assessment showing inundation relative to infrastructure – roads, settlements and so on (right)



## The Way Forward

ICIMOD is exploring ways in which multiple satellite image processing and analysis techniques can be applied individually or in a combined manner to serve rapid-mapping tasks to support disaster and crisis management. The focus will be on the following:

- Increased availability of consistent, comparable, and reliable high-resolution geospatial data
- Initiatives to establish a spatial data infrastructure (SDI) for the Himalayan region to facilitate access to reference data and dissemination of rapid mapping products
- Continued support and encouragement to ICIMOD regional member countries to use rapid satellite mapping to support disaster relief and demonstrate how this technology can be used for crisis management

- Continued support to capacity development in the region and development of a regional network to improve information management and transboundary cooperation using remote sensing and GIS
- Engagement in close networking with space agencies, regional and international charters, interdisciplinary, inter-organisational cooperation mechanisms, and teamwork

## Further reading

**Sentinel Asia** <http://sentinelnp.icimod.org/>

**International Disaster Charter** [www.disasterscharter.org](http://www.disasterscharter.org)

**Mountain Geoportal** <http://geoportal.icimod.org/>

WINDS ground station at ICIMOD



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