SATELLITE-BASED GLOBAL FLOOD RESPONSE

The Sichuan Earthquake (3)

The role of SAR imagery in emergency rapid response to global disaster is firmly established. Properties of imagery that must be considered in acquiring TerraSAR-X data for flood monitoring and mapping are discussed and a semi-automated process for flood assessment is described. Access to relevant data is crucial at the time of a disaster. The multi-mission platform UN-SPIDER not only provides access but also increases awareness of the value of such data.<P>

The last two issues of GIM International featured the valuable contribution made by spaceborne remote sensing to rapidemergency response activities. In the aftermath of the strong earthquake in the Chinese province of Sichuan, rapid emergency assessment and risk evaluation, e.g. flooding caused by natural dams, was crucial for onsite emergency response.

Background

Emergency response to the May 2008 Sichuan earthquake has already been described. Particular attention was given to four key issues: assessment of damage to buildings and other infrastructure, assessment of blocked or destroyed roads (i.e. accessibility of affected areas), detection of landslides, and detection of natural dams caused by these. The latter is particularly important with respect to assessing risk of flooding by water levels rising above dams and the risk of these breaking, resulting in catastrophic downstream flooding.

The significant potential of spaceborne SAR sensors in providing information for flood assessment and monitoring is well established. We investigate the application of semi-automated processing methods and examine the key role of SAR within the context of international multi-mission emergency response.

Flood Mapping

Since launch of the satellite in June 2007, TerraSAR-X data has been utilised in flood mapping and monitoring on several occasions and at locations as diverse as England, India and Mexico. This range of environmental conditions provides a basis for developing semi-automated methods of TerraSAR-X-based flood mapping and monitoring. Data analysis was undertaken by Infoterra, the German Centre for Satellite-based Crisis Information (ZKI), and by local organisations.

Acquisition Planning

First and foremost, programming of TerraSAR-X acquisitions for the affected regions needs to be initiated. This requires a number of decisions to be made regarding acquisition modes and parameters.

StripMap, ScanSAR or SpotLight

Mode of acquisition is best determined from the size of the area affected. ScanSAR provides the greatest area coverage from a single scene, with image dimensions of 100km (in range direction) by 150km (in azimuth direction,extendable to 1,650km) and corresponding ground resolution of 18m. StripMap scenes are acquired at 3m resolution and cover a 30km-wide swath with a typical length of 50km (also extendable to 1,650km). For a high-resolution image of a particular feature (e.g. city centre), the use of SpotLight scenes (10km by 10km, up to 1m ground resolution) is recommended.

Single (HH or VV) or dual polarisation? Acquisitions in HH deliver a higher contrast between water and land surface as compared to VV, and are therefore generally the better choice. The value of X-band cross-polarisation data (HV) needs to be further assessed. HV data is only available in combination with a co-polarisation channel. Any increase in information content as a result of using dual-polarisation acquisition modes must be balanced with the resulting reduction in coverage and resolution.

Incidence angle

In general, shallow incidence angles are preferable, as steep ones result in stronger backscatter for open water and reduce the contrast with land surfaces. In an emergency, however, acquiring the first possible scene of the affected area clearly takes priority. In parallel with acquisition planning goes a search for existing pre-event data. The first choice is previous TerraSAR-X data, allowing direct comparison. In the absence of this, data from other sources (including optical and/or airborne) is used.

Processing

The process of segmentation (using a combination of pre- and post-event scenes), followed by automated classification, facilitates identification of water bodies. The results are manually checked for quality and the need for manual refinement determined. In the case of

TerraSAR-X data, the need for manual refinement depends upon environmental conditions. Wind influences SAR-based classification results; the higher the wind speed, the rougher the water surface and the greater the radar backscatter. Current research aims at making the approach more robust in all wind conditions.
The final step in flood-mask production is the generation of two water masks in order to separate flooded areas from existent water bodies. Figure 2 shows a flood map created using this approach on a subset of a TerraSAR-X StripMap scene following the 2008 Mississippi flooding event.?

Flood Mapping

There are several advantages to developing this automated system as a multi-mission concept, applying data from various sources. Flood masks of the highest possible accuracy can be produced even in the absence of TerraSAR-X pre-event data. The revisit time (i.e. time between subsequent acquisitions of affected area) can be reduced with the application of data from multiple sources. This is an important factor when processes such as rising or falling water levels are to be monitored. Finally, for near-coincident acquisitions, new algorithms could be developed that utilise information from several sources to provide more accurate results.

TerraSAR-X, with its unique reliability thanks to regular revisits and ability to image day or night independent of cloud cover, is a key data source in emergency response. Nevertheless, this single source has to be seen in a wider context. The multitude of information required in the aftermath of a natural disaster is obtained more easily using a multi-mission approach.

Multi-mission Response

Since natural disasters and emergencies occur worldwide, the effective co-operation of all relevant global organisations (whether private- or public-sector) is essential to ensure fast and reliable information gathering and distribution. The first step towards establishing such co-operation is successful implementation of the International Charter ‘Space and Major Disasters’ (www.disasterscharter.org). In supporting the charter, operators of earth-observation satellites commit themselves to collecting and providing adequate satellite data, free of charge, to affected countries or regions.
Improved access to multi-mission data and information is also a key objective of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER (www.unoosa.org/oosa/en/unspider/about_us.html). This is a United Nations Office for Outer Space Affairs (UNOOSA) project that provides information to all countries and relevant organisations via a ‘knowledge portal’. The project supports the full disaster management cycle (prevention, preparedness, response and recovery) by providing disaster management support with access to imagery.

Outlook

Since launch of TerraSAR-X in mid-2007, Infoterra has supported numerous emergency response efforts. Its data shows promise both in its standalone approach and, more importantly, within the context of a multi-mission one. Recent activation of the charter on behalf of Haiti following hurricanes ‘Hanna’ and ‘Ike’ (Figure 3) once more demonstrated the potential of TerraSAR-X-based flood mapping as part of a multi-mission. The UN-SPIDER programme is an important platform, increasing awareness of the value of spaceborne remote sensing for emergency response within the global emergency-response community.

Highlighted in this, the last of a series of three articles prepared by Infoterra and LIESMARS/Wuhan University, is the role of TerraSAR-X in global emergency response and information exchange networks. The previous two articles dealt with the role of satellite imagery in emergency rapid response to the Sichuan earthquake and interpretation of data.