Disaster Management & Satellite Imagery

Space-programme research and development over the past five decades has culminated today in the broad practical application of advanced earth observation (EO) technologies. Satellite technologies are now reaching a level at which they can contribute significantly to relief efforts after natural disaster. It has often been proved over recent years that the rapid provision of high-quality radar and optical satellite imagery enables quick and detailed evaluation of disaster areas.

The earthquake which hit Sichuan Province in China on May 12 2018 was so strong that office buildings in Beijing (1,500km away) and Shanghai (1,700km) swayed; it left about five million people homeless, killed over 65,000 and injured more than 360,000. More than 20,000 people are still listed as missing. It was the deadliest and strongest earthquake to hit China since the 1976 Tangshan quake, which killed at least a quarter of a million.

Benefits of Satellite Imagery

In a joint attempt to help relieve the emergency situation in Sichuan, Infoterra GmbH and Spot Image SA have provided China with satellite imagery by tasking their respective satellites, the German radar satellite TerraSAR-X and the French optical satellite SPOT 5, to acquire data of the earthquake area. Seven hours after reception it was possible to deliver the first processed TerraSAR-X imagery, while detailed maps compiled from various evaluated and interpreted datasets could be delivered the following day. The major benefits of satellite imagery are its ability to capture a wide area in one go, and to acquire up-to-date information. When blocked roads limit human access, and aeroplanes and helicopters are either unavailable or useless due to bad weather conditions, satellite sensors can still take images; active radar sensors can do so by day and night and in all weather. These images may be used to collate inventories for monitoring and assessing affected areas and to prepare emergency response in even the most remote parts.

Time Lag of Satellite Imagery

That is the good news. Now the other. Experts agree that for prompt assessment of disaster damage, satellite imagery information must be released no more than three hours after the event. An EO satellite can take images only at specific times and dates, depending on orbit and swath width. This means a disaster area can be imaged only if the satellite is orbiting sufficiently close by. Time lag means that a satellite cannot always respond to disaster as quickly as needed. Furthermore, disaster areas are often subject to further devastation and ravage during the days following the calamity. For example, after the main tremor of the Sichuan quake, fifty-two major aftershocks were recorded within 72 hours. Such dynamics imply a need for permanent, ongoing observation, yet at best satellites can provide only daily coverage. For example, the Japanese Advanced Land Observing Satellite, Daichi, launched in January 2006 and designed for mapping purposes, with as spin-off application disaster management, can take images of the same area only every two days (see GIM May 2006, page 39). Four orbiting Daichi satellites would be required to capture the same area every three hours.

Ground-sampling Distance (GSD) and Spatial Resolution

In addition to the timelines, including revisit frequency and processing speed, ground-sampling distance (GSD), also called spatial resolution, is also of crucial importance. In sparsely populated rural areas GSDs of several metres may suffice for damage-assessment purposes, but this is quite inadequate when evaluating earthquakes affecting major cities. Here detailed images of at least 1m GSD are essential for assessing damage to streets and buildings. Launched on 15th June 2007, TerraSAR-X is a radar satellite that functions independent of weather conditions and has favourable resolution properties; in High Resolution Spotlight mode the GSD is better than 1m. Nadir revisit time is, however, eleven days. At two days, the revisit time of the Synthetic Aperture Radar (SAR) on board Daichi is much better, but its GSD is just 10m. The features of the EO satellites are such that their use alone cannot cover all disaster-management needs. But the weaknesses of one system may be the other’s strengths, so in co-operation they are able to meet a great proportion of the needs.

Global Earth Observation System of Systems (GEOSS)

To address the needs thus requires collaboration on a global scale. With this aim, more than seventy governments and forty organisations have joined forces to build a Global Earth Observation System of Systems (GEOSS). In ten years’ time, the thousands of observation instruments now operating in isolation will be linked together. They include in excess of sixty high-tech EO satellites; floating buoys for monitoring ocean currents, temperature and salinity, and air-quality and rainwater sensors. GEOSS is not focused solely on disaster mitigation, but also on water, ocean and marine resources, weather and air quality, biodiversity, sustainable land use, human health and well being, energy resources and climate change.

The second GEOSS Asia-Pacific Symposium took place from 14th to 16th April 2008 in Tokyo. Three hundred scientists and experts from across the Asia-Pacific region gave prime consideration to new technologies and strategies for assessing and predicting climate change, issues such as its impact on biodiversity and water resources, and monitoring forests and tracking the carbon cycle. I am pretty certain that disaster management will be high on the agenda for the next meeting.
