UNISPACE III - ISPRS/EARSeL Workshop on
"Remote Sensing for the Detection, Monitoring and Mitigation of Natural Disasters"
2:30-5:30 pm, 22 July 1999, VIC Room B
Vienna, Austria

REPORT

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Overview

The workshop brought together speakers who are experienced in the use of remotely sensed data for detection, monitoring and mitigation of natural disasters. They covered most of the hazards and disasters to which our planet is prone. A brief summary of the current status and future prospects in these areas is given below. The workshop started however with a review by Gudmandsen (Technical University of Denmark) of the capabilities of remote sensing techniques for monitoring natural disasters. He discussed a wide range of sensors including those little used at present such as real aperture radar, which is relatively low cost, and passive microwave systems which may be used for biomass determination and to measuring oil slicks. He evaluates the advantages and limitations of remote sensing and the possibilities of use for prediction.

Gudmandsen presented a possible scenario to communities living in disaster-prone areas the full benefit of the remote sensing techniques when needed. This requires considerable advanced activities and a large-scale co-operation between scientists in a number of disciplines and regional authorities. Existing data and information must be collected and co-ordinated. Planning and prediction is essential and real time interaction at the time of a disaster is very desirable. In many cases a co-ordination of the efforts by authorities in two or more countries will be required. Since disasters often involves large financial losses insurance companies may have an interest in participating. This involvement could lead to a change of the policies of urban and environmental planning. These themes were repeated throughout the workshop.

Earthquakes

Béquignon of ESA reviewed the contribution of space techniques to earthquake hazard management and showed that space technology does contribute to the scientific research and to general measures in earthquake management. Most earthquakes occur in well-known areas and while this is still a difficult task, risk maps and vulnerability maps may be drawn. Other techniques such as accurate positioning systems, involving laser tracking, and VLBI have been used for a long time. Nowadays, dense networks of GPS systems equip areas such as the Los Angeles basin. Such systems, and the novel technique of differential SAR interferometry, can accurately measure ground deformation, seismic displacements and plate motion rates.

It can be concluded that space systems can provide general purpose support such as telecommunications and mapping, they may also provide special support such as ground deformation monitoring but earthquake prediction remains largely beyond our capabilities, despite a number of on going research efforts. Earth observation can play a role in damage assessment and can play an important part in strategic activities but is of little tactical use. It is essential that all data is used effectively and there is wide scope of more research in generic techniques such as data integration as well as specific research related to earthquakes. Some new satellite systems will deliver more appropriate information and others will continue to contribute to the necessary basic research.

Monitoring Oil Spills from Space

Cauneau of Ecole des Mines de Paris discussed the use of space technology to monitor oil spills in the context of the constantly increasing pressure of human activities on the environment. Oil spilling has been highlighted as one of the most representative pollution mechanisms. Advanced monitoring techniques have brought evidence that for the most part marine oil pollution is not accidental, but chronic, covering the whole domain of shipping activity.

Synthetic Aperture Radar has been the dominant technology used during the last decade, among the results achieved, it has been shown that: anthropogenic oil spills at sea may be easily identified, at least on a statistical basis, since global mapping brings to evidence the correlation between slicks locations and the main shipping lanes; spilling appears to be less from oil tanker than classic ship transport and that there is a strong need for advanced tools to discriminate natural and anthropogenic slicks, especially in areas where the natural production of surfactants is significant.

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Natural Hazards of Geological Origin

Bannert of BGR and Missotten of UNESCO showed that natural geological hazards have become a significant threat to a large part of the world population. Remote sensing methods can be used to assess the potential for many natural and man made geological hazards. The Geological Application of Remote Sensing (GARS) Programme is addressing a wide variety of these issues in order to have more powerful tools developed to assess potential hazards, to monitor on going geological catastrophes and to register and appraise the damages occurred. The programme has addressed a number of essential problems in the past, including new methods for the integration of multisensor data to improve lithologic mapping in tropical environments (East-Africa); landslide mapping using GIS technology based on satellite data and new Radar information on test sites in Colombia and has demonstrated the use of remote sensing, SAR in particular, for the analysis of volcanic and associate hazards in the Philippines.

Drought and Desertification Monitoring

Belaïd (Moroccan Royal Centre for Remote Sensing (CRTS)) addressed the problems of drought and desertification with reference to a case study from Morocco. The approach adopted in Morocco includes diagnosis, assessment and analysis. The diagnostic activity demonstrated that excessive deterioration of vegetation and soil had occurred because of physical factors and human impact, of which mainly deforestation, overgrazing, erosion and salinization were dominant. Remote sensing was used in an operational way at national level for the development of environmental indicators (vegetation index, albedo, surface temperature, emissivity and thermal inertia) with the aim of producing risk maps. At local level, several applications were implemented in relation to the deterioration of vegetation and soil as well as the management of water resources.

The sectorial applications and the thematic projects reviewed above have demonstrated the operationality of remote sensing and GIS for studying the principal components of desertification. The complexity of the phenomenon requires the development of a desertification information system (DIS) permitting the integration and the modelization of the sectorial results.

Prediction and Prevention of Environmental Disasters

Linsenbarth (Institute of Geodesy and Cartography, Poland) discussed the use of photogrammetry and remote sensing in assisting with the problems brought about by environmental disasters such as floods, forest fires, volcanic eruptions or earthquakes which result in huge damage to the environment. Data should be georeferenced hence they should be created within the frame of spatial information systems. In many cases several disasters such as floods or forest fires have huge areal extent which sometimes also have a trans-boundary character. For the monitoring of such disasters remote sensing data are of first importance. This was illustrated by the catastrophic flooding which occurred in the summer of 1997 that affected the Czech Republic, Germany and Poland. The system described is incorporated in to the Polish National Crisis Management System.

The role of remote sensing in the forest fire disasters

Linsenbarth also discussed how remote sensing techniques and GIS systems can be used for prediction of the forest fire risk, monitoring of the forest fires and their spatial extent, inventory of the areas affected by fire and assessment of losses and monitoring of recultivation and reforestation efforts. He gave the example of the largest ever forest fire in Poland which was observed on satellite images. Analyses of the results were mapped in a georeferenced spatial data system and damage could be related to forest parameters.

Pollution and Hazardous Waste Sites

Singhroy (CCRS) provided a review of current remote sensing techniques for the monitoring of pollution on land and water. Several operational remote sensing and GIS techniques are now being used for mapping polluted areas and for monitoring the clean up and restoration activities. These techniques are also constantly being revised with the availability of higher spatial and spectral resolutions of new remote sensing systems. Singhroy focused on the integration of remote sensing and GIS techniques. Examples of the application of high resolution optical and SAR satellite images, as well as airborne hyperspectral were discussed.

Linsenbarth gave another example of the application of remote sensing for natural disaster monitoring and forecasting can be the so-called *Black Triangle* project conducted by the European Commission within the PHARE programme. Pollution problems cross boundaries and the importance of international co-operation is stressed for the establishment of common programmes and systems for early warning, monitoring and prevention.

Atmospheric hazards

Wood from NOAA explained how NOAA relies on Earth observing satellite data to carry out its operational mission to monitor, predict, and assess changes in the Earth's atmosphere, land, and oceans. In NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), satellite data are used to help lessen the impacts of natural and man-made disasters due to tropical cyclones, flash floods, heavy snowstorms, volcanic ash clouds (for aviation safety), sea ice (for shipping safety), and harmful algal blooms along U.S. coastlines.

Conclusions

There are well documented examples of remote sensing being used with great success for all of the activities related to hazards which have been discussed at the workshop, but there are also occasions where the potential resources have not been available, or have not been mobilised. There are several key themes which have emerged: international cooperation is essential; more techniques must be developed for integrating data from a variety of sources; and advanced planning and incorporation of remotely sensed data into existing planning systems is highly desirable.

In conclusion it can be stated that many techniques using Earth observation data are being used effectively to manage natural disasters but that more effort is needed if disaster prediction is to be a reality and also to plan responses. More research is needed to integrate and effectively exploit new data sources.

Summary of conclusions

The papers and discussion in this workshop have shown that remote sensing provides scientists the data needed for predictive modelling of natural disasters, appraisal of the damages, and for mitigating the deleterious effects which precede or accompany the disaster. Remote sensing is also recognised as an essential information source for the initial detection, near real-time observation of the effects, and support of search, rescue and assistance efforts. Many international cooperative activities are now being developed through the efforts of organisations such as CEOS and through international bilateral arrangements. The Workshop reviewed the status of these international efforts to use remotely sensed data for Monitoring and Mitigation of Natural Disasters and offers the following conclusions:

- In order to effectively use remotely sensed data for dealing with natural disasters, crisis management systems must be in place. This allows planning and collaboration between relevant agencies and rapid response to emergencies.
- Considerable international cooperative efforts are needed to use remote sensing data and information to develop indicators of disaster prone areas and mitigation strategies/scenarios.
- Integration of all available remotely sensed data and other types of data will greatly add to the value of all such data. Data integration techniques are being developed but further research into this is essential.
- Space imaging, communication and positioning systems can be effective tools for management of earthquake hazards. Space borne imaging systems can provide the indicators, maps and measurements of quake prone areas which can be used for evacuation routing, urban planning and vulnerability statistics.
- More research is encouraged to explore the potential advantages of new Earth observing remote sensing systems which have higher resolution, more spectral bands or use active sensors (interferometric SAR, Lidar).
- Spaceborne Synthetic Aperture Radars have demonstrated to be effective all-weather remote sensing imagers for oil pollution effects, especially for the detection of oil pollutants; measurement of their areal extent, direction and growth; and for identification of the pollutant sources in international waters.

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- Many remote sensing methods have been developed to assess the potential of geological hazards and to appraise the damages. These include methods for the integration of multi-sensor data to improve lithologic mapping in tropical environments, landslide mapping and analysis of volcanic and associated hazards.
- Satellite remote sensing has been demonstrated to be beneficial for identifying environmental indicators for producing risk maps of desertification, soil erosion and desalinisation, deforestation, overgrazing and over-development.
- Early warning systems rely on satellite imaging systems for detecting early stages of flooding, forest fires, volcanic eruptions and some pollutants.
- The detection, effects and characterisation of hazardous waste sites requires high spatial and spectral resolution remote sensing from visible, infrared and radar satellite images.
- Satellite data are used operationally to lessen the impacts of natural disasters such as tropical cyclones, flash floods, heavy snowstorms, volcanic ash clouds, sea ice, coastal water toxic effects and harmful algal blooms.

Many techniques using Earth observation data are being used effectively to manage natural disasters but more effort is needed to make disaster prediction a reality and to plan responses. More research is needed to integrate and effectively exploit new data sources.

(Relevant Paragraphs in UNISPACE III Draft Report A/CONF.184.3 are ¶34, 41-42, 44, 69, 74-75, 79-80, 82, 86, 90-91, 94-99, 102, 106-119, 127, 136-139, 301, 302, 339)

ISPRS/EARSeL Workshop on
"Remote Sensing for the Detection, Monitoring and Mitigation of Natural Disasters"

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