DIRECT RECEPTION OF SATELLITE DATA FOR IN-COUNTRY WARNING, MONITORING AND MITIGATION OF NATURAL DISASTERS IN THE DEVELOPING WORLD: THE LARST APPROACH

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Abstract

Remote sensing techniques can be used for a variety of practical hazard assessment and mitigation purposes in developing countries, but are largely underutilised. Satellites can be used to survey large areas, monitor weather and other changes in the environment and provide uniquely valuable overviews of inaccessible regions. But, as with other forms of environment monitoring and resource management, easy access to reliable and comprehensible information at the time of need is essential. The LARST approach group have developed practical and cost-effective techniques to provide such information based on direct local reception of data from free environmental satellites. Applications include warning, monitoring and helping to mitigate the effects of many kinds of disasters both natural and man-made: these include droughts, floods, storms, fires, pest plagues and volcanic eruptions.

1. Introduction to the issues

Global Scale Natural hazard assessment and mitigation needs to be seen within the wider perspective of planetary management Such activities are an integral part of monitoring the ever changing global environment for good management of increasingly scarce natural resources. Within this planetary perspective we are concerned here with warning of local upsets and mopping up the spills that inevitably will continue to occur, probably affecting increasingly large numbers of people.

57 varieties In nature there are a very wide range of disasters that affect people and their livelihoods. Not all are sudden and large: many are localised and some are very drawn out.

Be prepared Most potential disasters can be mitigated to a significant degree with good preparation: witness the different mortality and property damage rates from similar tropical cyclones in Florida and Bangladesh. Being prepared costs money though, and what proportion of very hard pressed budgets in developing countries can be allocated to prepare for possible disasters that might not happen for a year or two? A 'high profile' disaster really starts the aid funds flowing. There is real concern that in some areas (lack of) planning for desert locust plagues deliberately exploits this flush and drought of financial resources - to the detriment of both farmers and the environment.

Be informed To be prepared and to respond appropriately to circumstances as they develop requires reliable, timely and cost-effective information. There is a major need and a unique opportunity for satellite remote sensing to contribute here; one which at present is largely unfulfilled - though it need not be so.

The big issue How do we ensure that useful information is available to the right people at the right time in a cost-effective and reliable way? If information is not accessible and understandable by decision makers it is of little value. If satellite 'earth observation' information can be 'communicated' in an appropriate way then institutions and decision makers will adapt to make use of it, for the benefit of all. There are certain aspects of our current LARST activities which lead us to be guardedly optimistic here. LARST stands for Local Application of Remote Sensing Techniques: the low-cost approach to receiving, processing and using satellite data on the spot to assist with practical decision making, developed by an association of groups led by NRI and supported by ODA.

2. LARST view of satellites: an underutilised resource

Satellites as a source of information are grossly underutilised in developing countries even though conventional information networks in such countries are usually weak as well.

There are many different satellites and many more are planned for the next decade. Although few if any of the commercial satellite companies and space agencies cover their costs through selling data (so few are their customers), current plans will increase data flows a millionfold over the next 10 years. It is imperative,

if we are to manage our planet and its resources to meet our long term needs, that we make better use of this fabulous wealth of data, not least to minimise the impact of famines and other disasters.

LARST is working with low-cost in-country reception of satellite data, assisting customers in developing countries to access and use 'free' environmental satellite data to help inform their decisions. This work is giving us fresh insights into why these particular resources are so little used. The problems are more institutional than technical. With 'appropriate' modern technology, PC computers and a degree of enterprise, data from a much wider variety of different satellites could be accessed locally, and processed into useful information, especially if data policies could become more liberal. The difficulty lies in integrating remote sensing information into the development process in a sustainable manner.

3. LARST for hazard warning

Currently, besides the FAO GIEWS/ARTEMIS continental/regional early warning systems, several countries in Africa are making use of LARST equipment to receive METEOSAT and NOAA data to assist with early warning of potential hazards. These include:

i. Drought: Local monitoring of rainstorm activity every 30 minutes using METEOSAT thermal infrared (cold cloud duration) data provides useful 10 day or monthly area estimates of rainfall (see Grimes *et al.*, this volume) These allow agricultural departments and early warning systems to monitor seasonal weather conditions over the whole country in real-time, identifying areas with deficient or inadequate rainfall in a timely and cost-effective way. Good examples are Ethiopia, Sudan, Namibia and Zambia.

ii. Flood: Similarly, METEOSAT monitoring of catchments can assist with useful flood warning as was demonstrated in Sudan during the 1988 floods.

iii. Storms: Local reception allows severe storms to be tracked in real-time with METEOSAT and NOAA data, and warning alerts issued where and when appropriate (see also Foot, Longworth and Grimes *et al* contributions, this volume).

iv. Fires: Real-time fire monitoring by NOAA and GOES is eminently practical. Combination monitoring by polar orbiter and geostationary satellites shows particular promise for protecting forests, property and lives from fire (see Belward and Malingreau, this volume).

v. Pests: The most cost effective way to control migrant pests is to attack them early, before major outbreaks occur. This requires cost-effective local monitoring of rainfall and habitat during recession periods for efficient patrolling and timely control when necessary. Many of these pests (locusts of different sorts; armyworm: quelea quelea) inhabit vast relatively sparsely populated arid and semi-arid regions where satellite remote sensing should be by far the most appropriate monitoring technique (see Cherlet, this volume).

vi. Volcanic/seismic: The potential of satellites for early detection of volcanic eruptions and seismic activity (see Francis and Lockwood, this volume) towards better response is being worked on. Here again the value of remote sensing and satellite communication lies in its integration with other information for local response.

vii. Health risk: LARST is beginning to explore how NOAA and METEOSAT data can be used to monitor rainfall and vegetation change as proxy indicators for changes in associated disease vectors. Other workers have already demonstrated the value of these techniques for 'monitoring' certain animal disease vectors.

The opportunity exists for other, smaller scale disasters, to be mitigated or prevented by good early warning. Carefully planned local access to higher spatial resolution data would enhance some of the above warning capabilities, and open possibilities for further applications.

4. LARST for disaster mitigation

Once a disaster strikes, the local need for management information can become acute at a time when existing infrastructure may be at its weakest. Locally received meteorological satellite information could assist with management of relief operations as:-

i. Information on extent and severity of the problem, area of flooded land, storm damage zones, drought, fire or pest affected areas and the location and severity of damaged communications infrastructure.
ii. Forecasting of likely weather conditions to help in areas where particularly vulnerable (disaster affected) people are trying to survive.
iii. Planning and executing air drops and surface provision of relief supplies

Higher resolution data if available might also assist with management of survivor and refugee camps. LARST is working to develop an information system

Table 1. Local Application of Remote Sensing Techniques: Applications common to many countries that the LARST programme seeks to address using direct access to free environmental satellites

Technique	Domain of Application	Potential Benefits
1. Meteorological Applications		
Meteorological monitoring	Weather forecasting; ozone hole monitoring; alerts and advisories	Improvement of agromet services; personal security; disaster management; transport routing; frost forecasting
Rainfall monitoring	Drought/famine early warning; Flood forecasting; Barrage management; Pest habitat; Wetland management	Timely disaster mitigation; Protection of life; Optimal water use with efficient control; Agricultural input management; Timely pest control; Fisheries management
Storm development	Transport; Housing	Personal, social and civil aviation security
Snow monitoring	Water resources and steppe monitoring	Hydropower/irrigation and range management
Ice monitoring	Ice breaker navigation	Efficient maritime transport
2. Land Use Applications		
Vegetation monitoring	Crop forecasting, range and wildlife management; Fire risk; Forest change, Pest habitat assessment;	Optimise extension and marketing, minimising land degradation; Forest protection; Efficient management of resources
Ground temperature differentiation	Plant diseases, agromet zonation, prediction of pest development	Disease control, agricultural extension, land use planning, pest control
High temperature (Hot spot) detection	Fire detection, volcano monitoring	Forest protection; Personal security
Beacon tracking	Wildlife tracking, domestic herds, movement of fishing vessels	Conservation, rangeland management, protection of fishing rights
Monitoring water properties (temperature turbidity phytoplankton)	Lake resources, ocean resources and coastal zones	Total fishery resource management, sustainable fisheries, erosion control, red tide warning

to help ensure monitoring, needs assessment and relief operations remain coordinated.

5. Information, decision makers and lessons learned

Uptake and proper use of remote sensing information is far from trivial. Often remote sensing scientists try to produce highly quantified results from their techniques whereas decision makers may find qualitative information of a different nature more useful. For example, qualitative information on whether a flood situation is likely to get worse or improve may be of more practical use than a detailed quantitative assessment of the already flooded areas. Prior determination of the real information needs for disaster management in developing countries is a vital step in the transfer and sustainable adoption of such activities Subsequently, as response mechanisms become more accustomed to using remote sensing information, the ability to demand and to make use of more sophisticated and different kinds of information will develop: the standard organic 'development' process.

Multiple applications of data appears to be the most reliable way of ensuring that remote sensing activities for disaster preparedness are cost effective in developing countries. Table 1 gives some idea of the different ways in which data from NOAA and METEOSAT can be used to make useful decisions. By endeavouring to ensure that disaster preparedness is an integral part of operational environment monitoring activities, and that these needs are addressed within multidisciplinary development programmes, it should be possible to sustain particular disaster monitoring activities through the (hopefully) long periods when nothing much happens.

6. Future possibilities

Technically, the future is glitteringly bright. Data from the new and more powerful fleets of satellites already scheduled will enhance potential local disaster monitoring capabilities by leaps and bounds.

This will remain only a potential though unless major efforts are made to make best use of existing resources and techniques to address the real problems of decision makers, and integrate these techniques into operational practices.

7. How to do it

One way of getting started:

i Approach your national meteorological service and ask them what products they can provide already. Indicate the kind of information needed. Very often staff in meteorological services in developing countries are keen to assist but have little idea of customers' actual needs.

ii. If the meteorological service have not got adequate satellite reception equipment, try and obtain the absolute minimum necessary and lend it to the meteorological service in exchange for a sustained supply of information. Enhance their capability steadily as the flow of information progresses; encourage them to diversify into other applications.

iii. Link in the local university. Assist them to start using the free satellite data for training, education and research purposes. Encourage them to diversify and expand as well, but to remain practical. They must provide the next generation of satellite literate staff ready to find new ways of using the inexhaustible stream of satellite data.

iv If you need assistance consider approaching one of the international donors. Clarify your objectives and identify potential benefits first. Staff in donor agencies dream of receiving clear demands to meet real needs in appropriate cost-effective ways

8. Further information

If you require further information, write to the LARST group at NRI, Chatham Maritime, ME4 4TB, UK, Fax: 0634 880066/77.

Discussion

Dr. Williams emphasised that direct reception techniques were becoming increasingly successful in developing countries as the word spreads The plans of EUMETSAT to encrypt data from Meteosat were decidedly unwelcome, however, at least one member state advocated delaying the introduction of encryption until Meteosat Second Generation in 2000. The processing of raw data through to applications products is feasible on a PC because only a small area of interest is processed.