ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Towards regional cooperative mechanisms for managing floods and drought in Asia and the Pacific using space technology

ESCAP works towards reducing poverty and managing globalization

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APPENDICES

ABSTRACT

The disaster management community, especially in developing countries, would possibly have managed floods and drought better, had space applications been put to use more effectively. Earth observation satellites, which have long been used to support forecasting of tropical cyclones, flash flooding and seasonal drought conditions, have made phenomenal advances in recent years. Mapping the Earth’s surface is now 100+ times more accurate than it was 10 years ago; early warning and prediction of El Niño has improved to 100+ days; risk warnings pertaining to storms and floods have advanced by 100+ hours, among other improvements. These advances, however, have yet to translate into large-scale operationalization in the region. Regarding increasing risks emanating from floods and drought in the region, the present study has examined the gaps that exist between the operational needs of disaster management, the existing institutional capabilities, and the space technology applications. Harmonizing these calls for a set of strategies in terms of the national policies and capacity-building mechanisms – including the sharing of information and knowledge, and building regional cooperative networks. While touching on these aspects, the study identifies certain priority applications, such as risk assessment, improvements in early warning systems, and multi-tasking the emergency communications networks. The entry point, however, starts with the availability of suitable satellite data, value-added products and other services, which are becoming increasingly commercial, as well as knowledge- and procedure-intensive. The study, while dealing with such aspects, brings in the distinct role of ESCAP in support of developing and least developed countries with critical vulnerability and constrained institutional capabilities for harnessing the potentials of space technology.

I. INTRODUCTION

1. The social, economic and environmental costs of natural disasters, especially floods and drought in Asia and the Pacific, are on the rise. Touching all aspects of life and livelihoods, disasters exacerbate poverty, widen disparity and derail sustainable development processes. Technologically, the advances in early warning capabilities and other disaster management tools have made a dent in terms of reducing the losses. On the policy front, disaster management has attracted considerable attention. Collectively, international agencies, national governments and NGOs have been placing the focus on pro-active disaster management efforts, so the countries with enabling policies and institutional infrastructures have benefited from these developments. The developing countries of the region, however, characterized by (a) extremes of hydro-meteorological regimes, (b) demographic patterns driven by the livelihood compulsions of poor to live in hazardous terrain, and (c) constrained resources and weak institutional base, continue to live with increasingly vulnerability and risks, emanating from the recurrent floods and drought.

2. Information holds the key for managing floods and drought. Timely and appropriate information provides tangible benefits in terms of (a) minimizing the losses and reducing vulnerability, (b) serving as a commodity for public good, especially weather information, and (c) providing the backbone for contextual knowledge and wisdom. A comprehensive approach to disaster management involves four basic phases: mitigation, preparedness, response and recovery. Information gathered during one phase is often valuable when put to use in the other phases. Such interrelationships necessitate not only comprehensive information support that is timely and precise, but also the appropriate institutional frameworks ensuring generation/collection of information from the diverse sectors of development at various levels, their use and proper integration into decision-making processes.

3. Capturing the dynamics and dangers of floods and drought is a challenging task. The inherent complexities cause critical gaps between the information needs of stakeholders at various levels and the ability of national systems to meet them. Space technologies, which can address these gaps, hold considerable significance, but only if they are used operationally and integrated with disaster management systems. The integration of space technologies depends on the ability of individual nations, especially in terms of enabling institutional infrastructures and governmental policies. With this backdrop, the present study aims at (a) understanding the "dynamic equilibrium" involving the information needs of stakeholders, national capabilities and space systems, (b) identifying the "missing links", and (c) examining the feasibility of addressing these in the framework of ESCAP mandates and priorities.

II. DISASTERS IN ASIA AND THE PACIFIC: CHALLENGES

4. Asia and the Pacific are among the most disaster-prone regions in the world. Every year, disasters of all kinds result in huge loss of lives and property in the region, causing severe setbacks to the development process. Global disaster statistics for 1996-2000 revealed staggering economic costs estimated at US$235 billion and 425,000 lives lost (IFRC 2000). Disasters caused by natural hazards alone reportedly affected an average of

211 million people per year in the past decade. Asia bears much of the brunt, absorbing 80 percent of the total number of affected persons, 40 percent of total deaths, and 46 percent of the total economic losses (CRED n.d.). Further, the secondary effects and indirect costs of disasters have also caused long-term effects on societies, regardless of their level of development.

5. Asia and the Pacific are affected by almost every conceivable hazard – geological hazards (earthquakes, landslides and volcanoes); hydro-meteorological (floods, cyclones and drought); and other hazards such as epidemics, insect infestations and almost every imaginable hardship. The relative intensity of hazards, depicted in Table 1, brings into focus the fact that out of 22 countries in the region for which data has been analysed, 15 countries are severely affected by floods, while eight countries are severely hit by drought. Interestingly, the eight countries severely prone to the drought have also got the same levels of severity for floods. There are seven countries moderately prone to drought, and five of them are also moderately prone to floods. Broadly speaking, the region is uniquely characterized by the co-existence of floods and drought. A brief analysis of the incidence of floods and drought, in various subregions and some of the worse affected countries, is presented in Appendix A.

Table 1. Relative intensity of hazards faced by some countries in the region

Country	Typhoon	Flood	Drought	Landslide	Earthquake	Epidemic
Australia	S	S	S		L	
Bangladesh	S	S	S	L	L	M
China	M	S	S	L	S	L
Cook Islands	M	L	S	L	L	N/A
Fiji	S	S	M	S	M	N/A
Hong Kong, China	M	L	N/A	M	N/A	N/A
India	M	S	S	L	M	M
Indonesia	L	M	M	L	S	L
Lao PDR	N/A	M	L	N/A	N/A	N/A
Malaysia	M	S*	S	L	N/A	N/A
Myanmar	M	M	M	M	S	N/A
Nepal	M	L*	M	L	M	M
Pakistan	M	M	M	L	S	L
Philippines	S	S	L	S	S	L
Papua New Guinea	L	S	M	S	S	L
Sri Lanka	M	S	S	L	N/A	L
Thailand	M	S*	S	L	L	N/A
Viet Nam	M	S	L	S	L	L
Solomon Islands	S	S	L	S	S	L
Tonga	S	M	M	L	S	N/A
Vanuatu	S	S	L	S	S	L
Samoa	L	S	L	S	M	N/A

S: Severe; M: Moderately Severe, L: Low; S*: Coastal Flooding; N/A: Data not available

Source: IFRC 2000. *World Disasters Report 2000*, International Federation of Red Cross and Red Crescent Societies (www.ifrc.org/publicat/wdr2000).

6. In the region, the populations vulnerable to disaster risks are increasing. A large cross-section of communities continues to be vulnerable – poverty prevails, and population density, even in the hazardous areas, is continually growing. Furthermore, the Intergovernmental Panel on Climate Change (IPCC) has warned that the Earth's climate is very likely to change over the decades to come, with likely increases in temperatures, sea level rise, heavier rainfalls, and worse droughts. As anticipated, the extremes of weather variability at the local level that causes floods and drought are likely (a) to reduce the effectiveness of local capacity and indigenous coping mechanisms, (b) to enhance the risks to and vulnerability of the communities, and (c) to demand better information support and scientific knowledge to manage them. As disaster vulnerability poses greater challenges, their management emerges as an important development issue, and building national capacities in term of addressing the information needs of stakeholders assumes greater significance.

III. INFORMATION NEEDS OF THE STAKEHOLDERS

7. The disaster management community, one group of stakeholders, is the initiator of the user requirements as well as the beneficiary of the information products developed to effectively meet the decision-making needs for comprehensive disaster management. The community in most of the countries of the region has many members (GDIN 1997):

- Government (intergovernmental and interagency): national, provincial, local and international agencies in connection with emergency management, along with overall management of floods and drought;
- The private sector/public domain: for awareness, search and rescue, and critical infrastructure support, as well as overall management;
- Voluntary and non-governmental organizations: for assisting with relief and rehabilitation; mitigation, preparedness and public education;
- Academia and research community: for R and D support, data analysis, development of decision-support tools and public policy analysis.

It is worth mentioning that the community of stakeholders is undergoing rapid transformation as it assimilates critical technologies to improve the quality of disaster management. The community includes the most interdisciplinary public service professionals, cuts across all sectors of development, and implements all aspects disaster management policies and plans on the ground.

A. Policies: Trends and Strategies

8. Creating resilient societies is indeed a long-term vision. The global consensus on this has already been demonstrated on several occasions. While disaster management policies, especially in the developing countries, broadly address all the phases of disaster management, in actuality, much of the focus has been on disaster response rather than mitigation and preparedness. Having learnt much from disasters in recent times, the Yokohama Strategy and Plan of Action for a Safer World and the International Decade for Natural Disaster Reduction (IDNRD) set the following broad goals, as part of the global strategy towards sustainable development (ISDR 2002):

- National evaluations of vulnerability and of the risks posed by natural hazards;
- Medium- and long-term mitigation and prevention plans with cross-sectoral linkages, at the national and local level, including preparedness and community awareness campaigns;
- Access to worldwide, regional, national and local warning systems, in addition to the widespread broadcasting of warnings.

Recognizing the vitality of disaster management for poverty alleviation and sustainable development, Millennium Development Goals (MDGs) and World Summit on Sustainable Development (WSSD) could also successfully cultivate global opinion in this direction. In fact, WSSD provided a timely reminder to the international community that faulty development and inappropriate use of resources are contributory factors to natural disasters. The Johannesburg Plan of Implementation (JPoI) includes commitments related to disaster and vulnerability reduction and improved early warning.

9. It is clear that the growing trend to develop reduction plans by stakeholders derives from the ongoing shift from post-event relief and recovery to pre-disaster preparedness, planning and mitigation, and the decentralization of government responsibilities. Such plans envisage promoting a risk-based approach to development in which sustainable development is based on an understanding and management of all risks – physical, environmental, economic and social. This total risk management approach integrates the proactive mitigation of disaster risk with sustainable development (ISDR 2002; Cutter 2001). By integrating goals for disaster mitigation into regular development mechanisms of stakeholders, governments may achieve the long-term efforts necessary to reduce disaster vulnerability. National agencies, as well as international agencies such as the World Bank and Asian Development Bank, have begun to require the development of mitigation plans or the inclusion of mitigation features as part of their plans and funding for disaster reconstruction.

10. In the above context, there are three types of strategies being pursued by stakeholders towards disaster reduction in the region: government-developed, grassroots/citizen-led, and integrated private-public. The information needs for pursuing government-developed plans are generally more holistic. Grassroots mitigation strategies developed through involvement of non-governmental organizations and community-based organizations benefit from public involvement and support, particularly useful in policy implementation and public awareness. The most effective strategy has been partnership efforts, at various levels, involving the stakeholders from both government and grassroots organizations. These private-public partnerships are built upon (a) integrating the financial resources and regulatory role of the government with the activism and resources of civil society organizations and the private sector, and (b) sharing information and knowledge.

B. Policies: Information Needs for Implementation

11 Implementing disaster reduction policies through the various types of strategies, including the private-public partnerships, needs intensive information support for the stakeholders. Broadly, the information needs in support of implementing these policies are summarized in Table 2. In terms of information support to the multi-tier hierarchical strategies involving the stakeholders at various levels, a viable decision pyramid is

necessary. Information requirements in terms of the vulnerability/risk maps addressing multi-tier hierarchical strategies, for example, show the diversity of scale, contents, standards, formats and other aspects. Mapping scale becomes increasingly larger as we move away from strategies of planning and monitoring to the implementation by the stakeholders at various levels (Figure 1).

12. Viable, context–specific information systems, based on primary, core and secondary data sets, provide a trade–off, meeting the information needs through multisectoral information integration. It has been demonstrated by several case studies and operational practices in some of the developing countries of the region (Dehqanzada and Florini 2000). The information system may be classified into two categories: (a) pre-disaster baseline data about the country and risks, and (b) post-disaster real-time data about the impact and the resources available to combat it. These systems could be organized with the synthesis of spatial and attribute data sets to deliver the necessary products and services, as listed in Table 2.

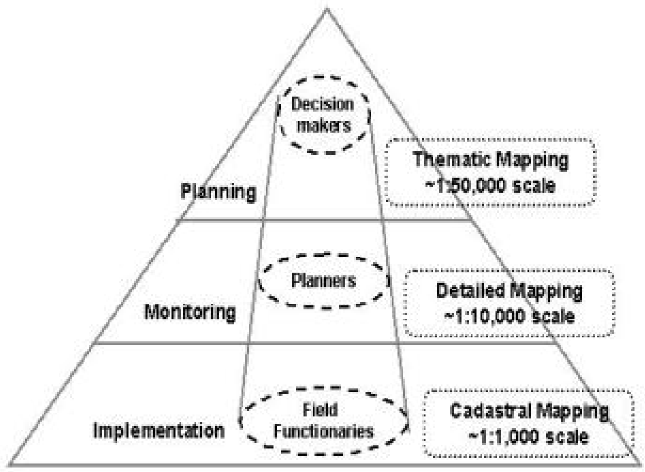


Figure 1. A decision pyramid, based on the hierarchical needs of information services for the stakeholders at various levels

Table 2. Broad information needs in support of implementing policies

Policies	Information Needs
National evaluations of vulnerability and risks, and medium/long-term mitigation and prevention plans	➢ Hazard assessment mapping ➢ Vulnerability assessment ➢ Risk assessment ➢ Large-scale spatial maps on demographic distribution, infrastructure, lifelines and critical facilities, logistics and transportation routes, and human and material response resources
Access to worldwide, regional, national and local warning systems	➢ Enabling information infrastructure – hydrometeorological networks, early warning systems, emergency communications backbone, and rapid mapping with near-real-time turn-around time.

13. Early-warning systems have made a substantial contribution to overall risk reduction objectives by enabling vulnerable groups to take timely action to mitigate loss and damage in advance of an impending hazard. Existing early warning capabilities for floods and drought, however, are often limited to the monitoring, forecasting, and telecommunication aspects. The multi-tier information systems, in conjunction with effective early warning systems, cater primarily to the information needs of the stakeholders at the various levels. Using them in conjunction requires the development of institutional capacity for risk analysis, warning, disaster preparedness and communication at the local level, as well as the horizontal and vertical flow of information.

C. Setting the Goals

14. A survey of nodal disaster management (information) agencies in 22 countries of the region, carried out to find out which of their priority activities are funded by the national government or international agencies, has revealed the following priority rating (Figure 2): hazard zonation and risk assessment (91%), early warning (81%), emergency communication (64%), impact mapping (45%) and damage assessment (27%). The surveyed countries are listed in Appendix A. Giving the highest priority to hazard zonation and risk assessment substantiates the perception that these activities are central to their disaster management framework. Obviously, information support is necessary to strengthen these activities. The goals could accordingly be (a) hazard zonation/risk assessment, (b) early warning systems, (c) emergency communications, and (d) impact and damage assessment. All these are highly information and technology intensive. It is important that the capabilities in the developing countries be strengthened to pursue such goals.

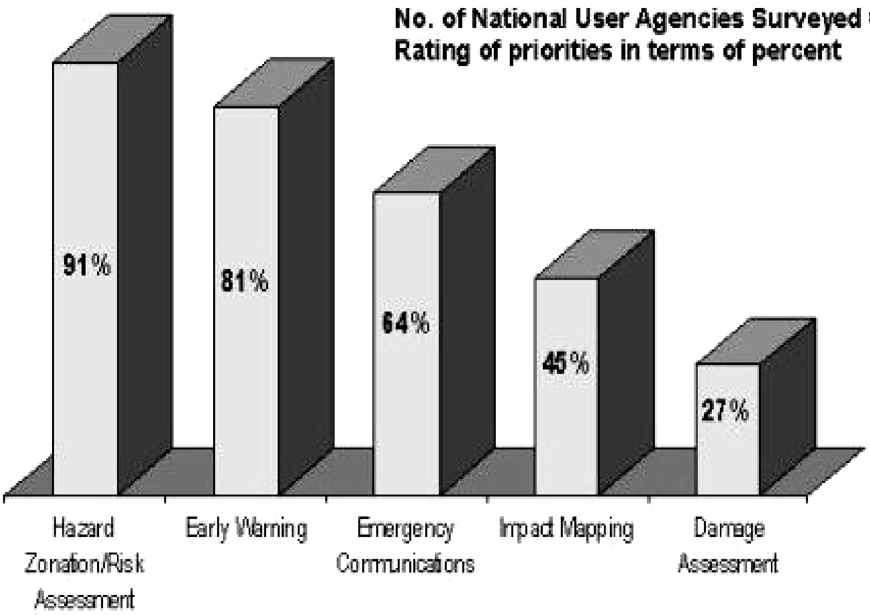


Figure 2. Results of the survey conducted on priority activities by disaster management agencies in Asia and the Pacific

IV. NATIONAL CAPABILITIES IN THE REGION

15. The ability of a nation to develop multi-tier information and early warning systems, as well as to make optimal use of these systems, depends on number of elements, such as abilities in the institutional base: (a) to produce hazard/risk maps, (b) to use them strategically for disaster preparedness, (c) to use them in hydro-meteorological networks for early warning, and (d) to ensure emergency communications support. This preliminary review of recent efforts to establish national or provincial Disaster Management Information systems in some countries of South and South-East Asia reveals that the countries do attach priority to such efforts and to making substantial investments in this direction (Appendix B).

16. A brief analysis of these initiatives indicates the following: (a) many of the information systems have been established as part of capacity-building and institutional development projects in the disaster management sector; (b) they use national technical institutions to implement the system and draw on the available data and information in country; (c) they are responding to felt needs within the sector, primarily for preparedness planning and post-disaster assessment and needs analysis; (d) relatively limited efforts have been made to use the systems for mitigation; (e) each initiative makes use of information technology and space systems to speed up both the collection and compilation of data, as well as to package the information in usable products as part of a decision-support system; and (f) many of the new systems have been developed with international funding either as part of broader capacity-building projects or within a post-disaster reconstruction program (http://www.adpc.net/infores/ir.html). A brief analysis of the effectiveness of national capabilities in the specific context of risk assessment, preparedness strategies, early warning and emergency communication systems is presented in the sections below.

A. Existing Capabilities for Risk Assessment

17. Mapping and risk assessment are the basis for policy, mitigation planning and implementation. If there are weaknesses in disaster management policies, the entire apparatus (laws, regulations, institutional arrangements and so forth) for dealing with risk will be prone to failure. Existing national capabilities for mapping and risk assessment often have severe limitations. In most of the countries, risk assessment is limited to hazard mapping, showing areas where different levels of hazard can be expected. Another dimension of the problem is that available risk information is usually too coarse in spatial and temporal resolution to provide useful information on increasingly complex and dynamic risk patterns. Coarse-resolution risk maps give the impression of uniform hazard and vulnerability patterns over wide areas. Limited assessment of risk may lead to widespread inaccuracies in the information produced. For example, a coarse-resolution risk map may indicate a large coastal area at risk from tropical cyclones and induced flooding but will be unable to provide information on significant differences in risk at the local level. Risk assessment needs to be able to deal with the increasing complexity of risk in order to be relevant to disaster reduction objectives. This ability, in turn, implies improving risk analysis capabilities of national disaster management agencies in most of the countries in the region.

18. The development of risk assessment is hampered primarily by a lack of adequate data in developing countries. Both cartographic and attribute data may have incomplete geographical coverage or be presented in unsuitable scales, be outdated or of dubious quality, or difficult to obtain. The absence of conceptual and spatial models capable of representing the social, economic and cultural dimensions of vulnerability is another problem. The recent developments in high-resolution imaging and GIS modelling have, to a certain extent, addressed this issue. In the developed countries, risk assessment is already a tool for insurance and other regulatory mechanisms. In developing countries, it is yet to gain momentum. In many developing countries in the region, national disaster management systems, particularly at the local level, generally lack the institutional and technical capacity or resources to create, sustain and maintain risk assessment.

B. Early Warning Systems

19. Early warning represents a cornerstone of disaster reduction. The forecasting challenge presented in providing early warnings spans a continuum from less than one hour for tornadoes and flash floods to seasonal and inter-annual time scales for drought. Warnings for these hazards can be provided only to the extent that the existing hydrometeorological infrastructure permits. While the global and regional hydrometeorological capacities are established operationally by several international agencies, the weaknesses lie in national and local infrastructures in many developing countries. In consequence, achievement of overall improvement in early warning for hydrometeorological hazards requires capacity-building, particularly at local and national levels, and improving coordination at local, national and international levels.

20. Flood forecasting networks, serving early warning needs, have been extensively developed in most of the flood-prone river basins of the region. Warning messages are issued in technical terms, viz., water levels and discharge rate at various places, thus limiting their value to certain levels of stakeholders only (higher-level administrators). The existing flood early warning systems have yet to be tailored to serve people's needs, their environment, and their own resources. Successful early warning requires unrestricted access to data that is freely available for exchange. It is important to support the development of early warning capabilities at the community level, based on local vulnerability and risk assessment.

21. An increasing body of evidence is encouraging disaster managers and politicians alike to invest in strengthening early warning systems. This provides additional opportunities for scientists and technical professionals, working in both public and private sector endeavours, to provide the benefits of their knowledge and make improvements in early warning. In the United States, for example, it is believed that improvements associated with the National Weather Service (NWS) modernization will more than pay for themselves. A National Institute of Standards and Technology cost-benefit analysis for the modernized NWS estimates that economic benefits to the nation will be about eight times greater than the costs involved, realizing annual benefits to the extent of US$7 billion (ISDR 2002).

C. Emergency Communication Systems

22. Although communication technology has a role in all the phases of disaster

management, most of the applications have traditionally been in the response and recovery phases. The convergence of technologies leads to greater possibilities for integrating different communication systems; therefore, interoperability of various systems, including the Internet, mobile phones, fax, email, radio and television, is becoming increasingly functional. As a result, the possibilities for their use in the mitigation and preparedness phases are also increasing. An assessment of their use, of course to a very limited extent, in developing countries of the region is summarized in Table 3.

23. A review of best practices pertaining to the use of emergency communication brings into focus the fact that the social and technical aspects need to be harmonized to ensure appropriateness. In case of disasters, it is not always true that the best communication systems work irrespective of the social environments and initial conditions with regard to enabling the infrastructure backbone (ADPC n.d.) It is necessary, however, to highlight that the institutional base in perennially flooded and drought-prone regions continues to be poor and digitally marginalized.

Table 3. A matrix showing the elements of emergency communication in practice

Emergency Communication Systems	Mitigation/Preparedness Phases	Information Management	Response (Post-disaster)
Public networks	• Information exchange • Survival and recovery capability of networks	• Routine telecommunications (phone, fax, telex, data) • Access to data networks	• International links • Local/regional links (if available) • Distribution of reports
Satellite telecommunication	• Local/regional data collection, data transmission for remote sensing	• Backbone network • Thin-route network • Permanent digital links	• International links from disaster site • Backup for regional and international links
HF and VHF radio communication	• Decentralized means of telecommunication with high survival capability • Frequency allocations for humanitarian needs	• Interface between emergency telecommunications and routine systems	• Regional and local emergency telecommunication links • Backup for international links

V. SPACE-BASED SYSTEMS AND SERVICES

24. The role of space applications in disaster management lies in its critical ability to produce as well as disseminate the information – on a real- or near-real-time basis. However, the true strength of theses applications can be realized only in the synergy and convergence with other collateral information, as well as with traditional technologies. The role of agencies involved in space applications holds significance in terms of enabling this to happen and adding the appropriate value to the satellite data so that the final delivered products will be in harmony with the operational needs of the disaster management community down the line. This is where the role of space agencies assumes vitality and is of operational importance.

25. Developments in space technology offer a tremendous technological potential for addressing critical information needs during all the phases of disaster management, which include mitigation and preparedness, response, and recovery and relief. Remote sensing satellites provide a synoptic, multispectral view of terrain and its changing land use and land cover, with varying spatial and temporal resolutions. Addressing all the operational and institutional aspects, the Disaster Management Support Group of the Committee on Earth Observation Satellites (CEOS) has brought out a comprehensive report on the role of remote sensing in disaster management (CEOS 2001). The operational role of satellite communications in providing emergency communications – satellite phones or point-to-point networking solutions routed through the arrays of VSATs deployed in remote and inaccessible areas, in early warning systems for floods, cyclones, drought and so forth – is well demonstrated.

26. Space applications have been put into operational use, to a limited extent, in flood and drought management worldwide. In the developed countries, especially the United States,, Japan and some European countries, space-based systems and services are well integrated with contemporary technologies to form the backbone of the overall disaster management system. Even several developing countries have started employing space applications as a part of their disaster management strategy. China, for example, has a space-technology-based flood management system, wherein the combined airborne and satellite-based systems provide reliable operational support. India has been using NOAA AVHRR/IRS WiFS-derived Normalized Difference Vegetation Indices (NDVI) for agricultural drought assessment to provide accurate information for relief operations. The Food and Agriculture Organization of the United Nations (FAO) has set up space-based systems in Africa for drought monitoring and addressing the food security issues in the region. The countries of the Mekong River basin have been using remote sensing data for flood monitoring. Worldwide, such systems have helped the disaster management community immensely to reduce the impacts and losses due to the recurrent natural disasters in their countries.

27. In the last few decades, remote sensing and GIS applications have graduated from the experimental demonstration and semi-operational state to operationalization in certain areas of flood and drought management. This process of operationalization, limited but critical in supporting flood and drought management, has led to several important results:

- Sensitization and awareness-building among user communities about the technological capability;
- Establishment of operational reliability in addressing a number of important management issues;
- Visible willingness of policy makers, administrators at various levels, academia, NGOs and the people at large to accept the accuracy of the services.

Highlights of CEOS Recommendations

- There is a general reluctance in the disaster management community to assimilate new technology and information quickly, because of a concern for introducing new, unproven technology into operational programmes. They also often lack time, resources, personnel, or technical understanding to make use of it.
- The space and services communities must create the appropriate tools and continue to perform compelling demonstrations. The central challenge relates to the promotion of mutual understanding and dialogue between the disaster management and space sectors
- Timeliness, cost, accessibility, ease of use, reliability, repeatability, and demonstrated operational capability are all critical factors that affect successful incorporation of space systems and data into disaster management programmes.
- Space agencies should address each factor on its own merits, since user acceptance does not necessarily increase by trading one factor off against another.
- There is need for a broad-based data policy that would improve and assure access, timeliness and affordability of data, including (or especially) high-resolution data streams.
- Space/CEOS agencies should work together to advance common data policies, where possible, to facilitate ready, affordable access to Earth observation satellite data for emergency use. (The data charter, announced at UNISPACE III by ESA and CNES, may provide a starting point.)
- Timely disaster warning and response, and/or rapid response in support of a disaster situation, is the most important feature in the utility of satellite technology.
- Space agencies and service providers should work to support fast processing and delivery of data, which will also be very important to determining the utility of space data for disaster applications.
- Typically, users can benefit from satellite data that is provided from more than one agency. Initial project efforts to develop information tools to demonstrate timely access to satellite-derived data and information products received positive reactions. It was recognized that there is merit in moving in a collaborative fashion towards a more integrated approach to mission planning.
- Initial steps should be taken towards sharing technical information and developing tools for satellite tracking and tasking that are more user friendly for disaster management support purposes.

(*Source*: http://www.ceos.org)

A. Status of Operationalization

28. Remote sensing GIS technologies have demonstrated their operational potentials, through several case studies on best practices, towards creating and updating information, such as (a) land-use/land-cover databases, (b) status of physical infrastructure, (c) geology and terrain maps revealing susceptibility to hazards, (d) watershed characterization and prioritization, and (e) rapid mapping showing disaster impacts and damage. GIS helps in integrating this information with information on social, economic and climatic vulnerability. Remote sensing and GIS thus facilitate the creation of hazard zonation and risk assessment processes – synthesizing all the aspects of vulnerability.

1. Addressing the Gaps

29. It is equally important to highlight that the information emanating from remote sensing and GIS addresses the gaps in the conventional systems of information generation. For example, in the matter of flood forecasting, the information that is available from the

conventional early warning systems to the stakeholders is water-level rise and the volume of discharge, based on gauge-to-gauge correlation data. There is no spatial dimension to highlight which areas or settlements are likely to be affected. The use of remote sensing and GIS inputs into the conventional systems enables the disaster manager to identify those vulnerable areas/settlements. Similarly, there is no scientific basis for identifying areas that have been affected during the different flood waves, but remote sensing and GIS can address such gaps. Some of them are summarized in Figure 3. Yet another highlight of such service is the quicker turn-around time for information delivery (subject to the technology and related institutional factors), which is of much greater value, especially in the case of flooding.

Information services from the Conventional Systems

Phase	Basis	Inadequacy
Event, Preparedness, Forecasting	Gauge to gauge correlations	Spatial elements
Relief/ Rehabilitation/ Impact assessment	Impressionist/ Subjective	Scientific basis
Mitigation/ Preparedness	Vulnerability zonation	High resolution mapping, DEM/ DTM, Updation

Towards bridging the information gaps

Supplementary/complementary information emanating from demonstrated Remote Sensing Applications

Phase	Products	Services
Event, Relief & Rehabilitation	Flood inundation map, Flood damage assessment	Organizing Relief & Rehabilitation operations
Reconstruction, Mitigation, Preparedness	River basin characterization, Bank erosion, Identification of chronic flood-prone areas, & Floodplain characterization	Flood control works, Planning anti erosion works, Hazard Zonation, Risk assessment for floodplain regulation, building codes & insurance

Figure 3. Use of remote sensing and GIS to address the gaps in conventional systems

30. Similarly, in the case of drought, remote sensing and GIS work as gap fillers and address the inadequacies in the conventional systems. The gaps in conventional systems lie mainly in terms of spatial elements, such as in-season information pertaining to land cover, showing the vegetation stress, associated agro-ecological factors and cropping systems, status of surface and groundwater, fodder status and the like. Besides addressing these gaps, remote sensing and GIS help in connecting the social, economic and climatic levels of vulnerability. A list of the deliverables addressing the information needs for floods and drought management is presented in Appendix C.

2. Issues and Constraints

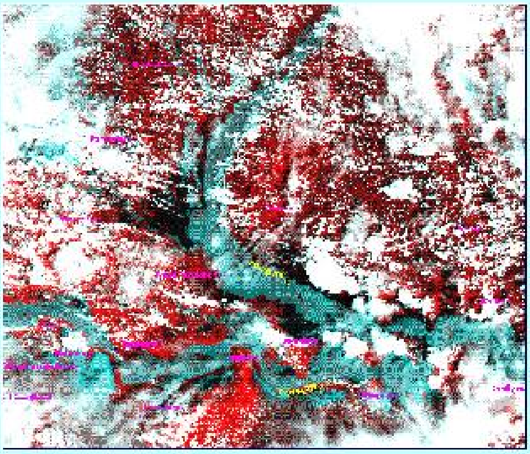
31. These applications could demonstrate the efficacy of remote sensing and GIS and could serve as valuable inputs for planning, policy-making and monitoring, to a limited extent. However, in some areas of applications, like impact mapping and damage assessment, their operational utilization down the line has been limited, constrained by a number of factors:

- Gaps in the quality of the product delivered and information content vis-à-vis the specific needs of the end-users down the line; the gaps in the case of floods and agricultural drought are listed in boxes 1 and 2 (some countries have their own airborne synthetic aperture radar (SAR) to address this gap);
- Not enough real-time information dissemination to the end-users;
- Lack of institutionalization and inadequate organizational mechanisms to integrate space applications for decision-making by end-users.

Box 1

For example, what was being delivered for floods?

- A satellite image (if cloud free scene is available) showing broadly inundation
- Image was disseminated by speed post/by flight to the users
- It was serving the purpose of sensitisation and building the impression about potential damage



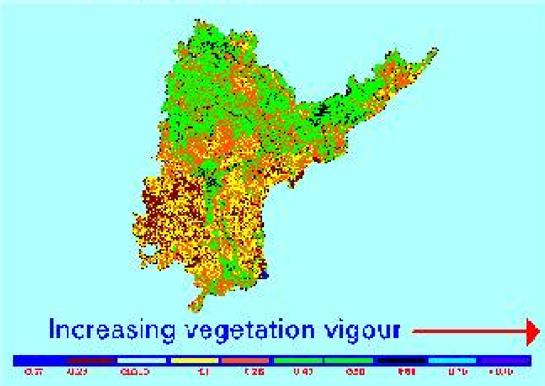
What did user community require?

1. Name and Number of villages marooned during the different flood waves
2. Total population affected
3. Total cattle population affected
4. Agricultural crop damage
5. Infrastructure damage
6. Flood-induced vulnerability (erosion, siltation, status of embankment)

Box 2

For example, what was being delivered for drought?

- A satellite image showing Normalized Difference Vegetation Index (NDVI) variations
- NDVI images give broad level qualitative and relative agricultural drought scenario
- It was serving the purpose of sensitisation and building the impression about potential impact



What did user community require?

1. 1. Name and Number of villages affected due to drought
2. 2. Total population affected
3. 3. Total cattle population affected

B. Use of Satellite Meteorology for Flood and Drought Management

32. Meteorological satellites have long been used to support forecasting of intensive weather hazards such as tropical cyclones, severe storms and flash flooding. Measurements from meteorological satellites, together with surface measurements and data from long-term archives, have resulted in better prediction of El Niño, which causes major weather disturbances, from drought and abnormally warm periods to unusually high rainfall, in locations around the entire planet. Advances in satellite meteorology associated with coupling oceanic and atmospheric observation systems has contributed immensely to improved in climate prediction. Concerted efforts by space agencies are likely to improve the prediction of weather hazards further. There have been numerous experimental and operational demonstrations that illustrate the potential usefulness of meteorological satellite data for a broader range of hazards. Better predictions and forecasts about the onset and consequences of natural disaster have tremendous potential for providing tangible economic benefits to governments, businesses and individuals, and especially to the poor.

33. It is also important to recognize that the predictions and forecasts from the meteorological satellites are at a coarse scale and, for the most part, are based on generic information available in the public domain. The generic information has to be interpreted in the local context by appropriate value addition and by converting the content into the locally relevant information services. For example, the El Niño of 1997-1998 was predicted with several months lead-time. However, in the absence of local and national ability to downscale these forecasts to the local level and make them usable for specific action, the forecasts could not be used fully to mitigate the negative impacts of El Niño and enhance the potential benefits. There remains a large gap between the scientific knowledge about the weather hazards and the ability of the users to put this knowledge to work in reducing the costs of natural disasters.

C. Use of Satellite Communication for Emergency Services

34. Traditional terrestrial telecommunications – particularly in remote areas of disaster-prone countries – are costly to install, difficult to repair, and vulnerable to damage. Fixed satellite services – though useful in disaster preparedness and warning – have demonstrated relatively limited effectiveness in disaster response, principally because of their own vulnerability to disasters. Their relative utility has also been affected by the need for large receiving and transmitting antennas, with their associated high power requirements. Mobile services by satellite, however, have proven valuable to disaster managers. This low-cost emergency communication capability has proven, even in the relatively short time of its commercial availability, to offer dramatic results in relief efforts, which had not been possible before. Furthermore, as a complement to remote sensing, Global Positioning System and GIS applications, it has the capability to improve risk assessment, disaster preparedness, early warning, and relief operations dramatically. This service is now available to areas previously considered inaccessible because of location, terrain, weather or demography.

1. Synergy of remote sensing, GIS, satellite meteorology and satellite communications

35. While it seems obvious that the synergy of remote sensing, GIS and satellite communications provides a unique combination of tools to address disaster management issues appropriately, realizing their potential operationally is quite challenging. There are, however, some examples where such synergy has been established in the institutionalized framework in the developing countries. For example, the National Remote Sensing Centre of China provides yet another example wherein the synergy of meteorological satellite (Feng Yung satellites), remote sensing (ERS/Radarsat/Landsat), and airborne synthetic aperture radar (SAR) is established to monitor and carry out damage assessment activities during floods. The airborne SAR data are disseminated to the user agencies on real-time basis via satellite link. "Best practices" have been found (a) in combining satcom, remote sensing and GIS and GPS in an institutionalized framework with multisectoral linkages, (b) identification of the regions that have the highest amount of risks, emanating from multiple hazards, as well as the safest zones, to help policy formulation towards disaster reduction, and (c) the use of remote sensing for rapid mapping of disaster event and of a satcom network to disseminate the information to the end-users on a real-time basis.

2. Cost Effectiveness

36. Setting up the institutional infrastructure for space applications involves high costs, may have a long lag time, and requires skilled manpower and governmental support. As an input to policy, planning, and monitoring and evaluation, which contribute more in terms of social and environmental gains than the benefits in terms of money, the cost-benefit analysis of remote sensing and GIS, like many other societal projects, is not an exact science, and currently lacks consistency. On the benefits of using remote sensing and GIS, the majority view is that maximum benefits can be realized only when the technology is fully operational. Yet another aspect worth highlighting is the catalytic role that remote sensing and GIS could play in flood and drought management. For example, in drought mitigation programmes such as watershed development, reclamation of environmentally degraded lands, and the like, the remote sensing and GIS aspects cost hardly 1-2 per cent of the total project cost, but they play a critical role in terms of benchmarking, monitoring and evaluation – leading to the successful execution of drought mitigation projects in semi-arid areas.

37. In spite of the direct and indirect benefits emanating from the use of remote sensing and GIS, it is important to examine the issue of cost-effectiveness more in quantitative terms. In today's context, there are increasingly higher demands for high-resolution remote sensing images for various applications, including disaster management. On average, commercial prices range between US$1,000 and US$4,000 for a single image with a ground resolution of 10 metres to 1 metre. Generally, the cost of imagery increases proportionately with either higher resolution or greater area coverage. At these prices it is unlikely that anyone except well-funded government agencies and large corporation will able to purchase large quantities of commercial satellite imagery (Dehqanzada and Florini 2000). The cost of images is just one aspect; there also must be investments in creating institutional infrastructure for further analysis and value addition to meet the specific users' requirements down the line. However, the lessons learnt from success stories, especially in the developing countries, amply demonstrate that, while the use of remote sensing and GIS involves substantial investment, they hold greater promise in building a more resilient

society. These investments should also be seen as a part of the country's concerted long-term sustained efforts in building a state-of-the-art national infrastructure for disaster management.

3. Can Least Developed Countries Afford Space Applications for Flood and Drought Management?

38. Affordability has always been a major issue with regard to the use of space technology applications, especially in the context of least developed countries (LDCs). The vitality of space applications in recent years has shown that even LDCs are making investments in spite of the competitive demands on their resources:

- Bangladesh signed a US$3 million contract with Radarsat International (RSI), from Canada, on 12 February 2003 to expand its water and information network pilot project into a nationwide GIS-based network, initially using data from Radarsat-1 and later from Radarsat-2 and the European Envisat. In addition to a Website, flood forecasts and water information will be disseminated to local farmers and citizens by radio and television broadcasts in local languages and by relaying information via a "citizen network" of cellular telephones;

- Canada signed an agreement on 5 December 2002 to provide remote sensing data and technology transfer to the intergovernmental agency the Mekong River Commission of South-East Asia. The Commission's members – Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam – are using Radarsat data for monitoring rice crops, flood inundation, irrigation water management and assessment of agricultural drought (IAF 2003).

39. There are several instances in which LDCs have paid for the high cost of the satellite data as well as the services emanating from space applications. It is understood that a country wanting satellite data and associated services, which are indispensable for disaster management, has to pay the cost. However, information support for disaster management involves more than just data. Besides substantial value addition to the satellite data, several interconnecting steps are typically required to generate the variety of the products and services in response the hierarchical needs of the stakeholders. A comprehensive disaster information system that allows access to much kind of information at many levels of details and many points of time is depicted in Figure 4. This calls for substantial capacity-building mechanisms before satellite data can be converted to useful information products and services.

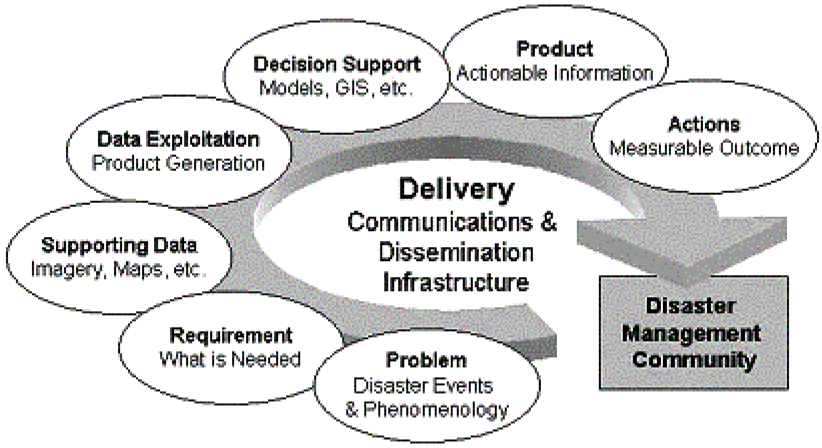


Figure 4. The cycle of value addition to satellite data before it is converted to useful information products and services

Source: GDIN, 1997. *Harnessing Information and Technology for Disaster Management*. The Global Disaster Information Network (GDIN), Disaster Information Task Force Report. November 1997. United States Department of Commerce.

4. Information for Action and Decision-Making: Where the Gap Lies

40. Although better information about floods and drought has the potential to yield tangible economic benefits, the gain from better information depends not only on the quality of information, but also how it is put to use. For example, a vulnerability assessment in the floodplains or perennially drought-prone areas will have a greater potential to mitigate future losses if the information is made available in a way that encourages stakeholders to act on this. Regulatory actions such as building codes or evacuation plans, insurance coverage, relief and so forth by national, provincial, or local authorities may be needed to fully capture the cost savings from reduced uncertainty about vulnerability and risks (Williamson et al. 2001). This is where the technological, institutional and policy-related issues assume significance.

41. Building institutional capabilities in developing countries is therefore a major issue. All the steps – such as converting satellite data into useful information and services, enabling stakeholders to use the services for making decisions, positioning institutional mechanisms as part of a reliable national disaster response facility, and integrating the national endeavours with international systems – essentially depend upon the capacity-building. This is where the developing countries, especially LDCs, need to be supported. Capacity-building, a long-term investment towards creating a disaster-resilient society, can be most significant when it harmonizes the needs of stakeholders and employs the full capacity of national information and communication resources and space-based systems and services.

VI. HARMONIZING THE NEEDS OF STAKEHOLDERS WITH NATIONAL CAPABILITIES AND SPACE SYSTEMS

42. Among the various factors that enable harmonization of the needs of stakeholders

with institutional capability and space systems, role of space agencies – both in public and private sectors – has been critical. Their roles are driven by the dynamics of technology trends, new policy regimes with regard to data, and the costs, accessibility and other associated services. It is therefore important to examine the changing roles of space agencies, especially those engaged in Earth observation and satcom, so that appropriate recommendations can be made towards harmonization.

A. Earth Observation Satellites: Emerging Trends

1. The Role Players: Space Agencies

43. World-over, Earth observation is experiencing a paradigm shift with endorsement of Earth observation for earth system studies and global change as a public good activity and the shift of high-resolution imaging to the commercial domain. The trend is also towards smaller missions, rather than the typical "one-stop-shop" missions of the past. The international scenario of Earth observation is likely to be dominated by the missions of NASA/NOAA, ESA, NASDA, CNES, CSA/CCRS, ISRO, and a few commercial satellite operators. Apart from these, China/INPE, Australia, Taiwan Province of China and many first-entry missions are also in operation, and other countries have planned their own missions. The data cost is a major debate, and there is a delicate balance between the cost-recovery and cost-of-fulfilling-user-request approaches that agencies adopt.

44. With regard to meteorological observation, the polar and geostationary platforms have continued to provide cloud pictures and various meteorological observations through a wide array of instruments. NOAA, GOES, Meteor, Feng Yung, Meteosat, INSAT and Metop, to name only a very few, are providing meteorological images and data to the disaster management community in the region.

2. Trends in Earth Observation Missions

45. In the 1980s, Earth scientists had a significant influence on Earth observation mission design and emphasized the need for studying coupled Earth processes, so they asked for "multidisciplinary" observing systems with multiple instruments and covering a range of land, ocean and atmosphere parameters at the same time, rather than specific parameters. In the mid-1990s, several private enterprises – Space Imaging, Orbital Sciences, DigitalGlobe (until recently Earthwatch), Boeing and others – obtained licenses from the Government of the United States to operate high-resolution Earth observation satellites - mostly with around 1-m-resolution capability. Radarsat International is another commercial operator, engaged in marketing Radarsat data. These companies apparently have diverted advanced technologies (hitherto in the defence domain) to the civilian Earth observation satellites and planned for low-weight, agile satellites with the ability to view "very small" areas of the Earth (~ 10 x 10 km scenes), thus, making a niche for themselves that could replace aerial photography. The status of Earth observation missions and the respective agencies are summarized in Appendix D.

46. Based on the analysis of existing trends, it seems that multispectral imaging is still the core of most missions and the trend there is to reach high resolutions – stabilizing at about 2-10 m with moderate swaths (about 40-150 km). The fusion of high-resolution

multispectral images with high-resolution panchromatic images is likely to result in potent data sets not only for disaster management related applications but also for precision, large-scale mapping applications.

47. An emerging trend is the constellation of microsatellite dedicated for applications related to disaster management. The Disaster Monitoring Constellation (DMC), for example, is a novel international cooperation in space, formed through an international partnership between organizations in Algeria, China, Nigeria, Thailand, Turkey, the United Kingdom and Vietnam. The status of the DMC Consortium is briefly summarized in Table 4. The DMC satellites can operate alone or in tandem. It provides global daily revisit at the equator and several daily revisits at mid and high latitudes, with 32 m multi-spectral imagery. The imagery is acquired via a global network of ground stations and rapidly distributed to where it is needed. During natural disaster, such as widespread flooding, the satellite will help relief efforts by re-imaging the affected areas at least daily, in contrast to the larger satellites now in orbit, which may take many days to revisit a specific area. These space resources place the DMC in a distinctive position to provide Earth observation images to the international disaster relief community in partnership with Reuters AlertNet.

Table 4: The status of DMC (Source: www.sstl.co.uk)

DMC Partners	Satellites
Algeria: Centre National does Techniques Spatiales	AlSAT – 1(launched 2002)
China: Ministry of Science and Technology	China DMC+4 (under construction)
Nigeria: National Space Research and Dev. Agency	NigeriaSat-1(launched 2003)
Turkey: Tubitak-ODTU Bilten	BILSAT-1(launched September 2003)
UK: British National Space Centre	UK-DMC(launched September 2003)

3. *Earth Observation Data Acquisition and Dissemination Scenario*

48. Advances in storage technology and processing and network technology are making ground stations less critical for global Earth observation missions – most missions are planning for high-volume mass storage devices and centralized data archival and dissemination systems. Maintaining a global archive of images and establishing time-series data sets is increasingly being employed by many space agencies. Dissemination of Earth observation data (even with high resolution and large volume) on networks is gradually becoming the order of the day.

49. On the data acquisition and dissemination side, there are two major trends that are developing – first is a global archive of Earth observation data and its distribution through a data information system (DIS) for science users, and the second is commercial distribution of Earth observation data through a “distributed” acquisition/distribution system on a cost-recovery basis, either partial, as in cost-of-fulfilment-of-user-request (COFUR), or total recovery. Yet another trend that has been adopted of late is the direct reception of data by the user through low-cost data reception terminals. These terminals provide flexibility to users so that they can receive on-line the data they need and choose, directly to a PC or workstation for immediate analysis.

4. Commercialization and Global Transparency

50. With its considerable potential for all kinds of uses, the market for satellite imagery is already growing. Over the past decade it has more than tripled in size, jumping from US$39 million in 1988 to US$139 million in 1998. It is estimated that by 2005 the market will reach US$420 million (Worldlink n.d.). The emerging market prospects have brought the commercial remote sensing industry into the game. Soon, at least 11 companies from five different countries are expected to have high-resolution commercial remote sensing satellites in orbit. These new satellites will have capabilities approaching those of military spy satellites, but with one key difference: their images will generally be available to anyone able to pay for them.

51. This new technology raises a host of policy concerns with which governments, business executives, and analysts around the world are just beginning to grapple. Public availability of timely, high-resolution imagery represents a notable break with the past. On 25 April 2003, the United States announced a new commercial remote sensing policy that directs all United States agencies, defence and civil, to look first to the private sector to meet their Earth imaging needs. The policy also eliminates prior technical constraints (on satellite resolution, for instance) and eases export licensing of remote sensing technology (United Nations 2000). We are moving from an era in which only a handful of governments had access to high-resolution imagery to one in which every government, business and non-governmental organization will have access.

52. In the realm of GIS, recent developments are more user-friendly, with better ease in learning, Web-accessibility and cost-effectiveness. The addition of the Amber flash flood forecast model to ArcView is good evidence of mainstream GIS capabilities in the area of flood management. Internet mapping capabilities, Web-based systems like Mapquest, and more on-line source data, available gratis or at a modest cost, have increased the accessibility of GIS data. The release of Microsoft MapPoint, its integration with Microsoft Office, and the downloadable add-in that permits importation of MapInfo and shape files suggest that Microsoft may eventually integrate more substantial GIS capabilities into Microsoft Office (ESCAP 2003).

B. Satellite Communications (Satcom)

53. The role of satellite communications continues to grow, in spite the efforts being made by the developing countries to promote terrestrial systems. However, traditional satellite communication operators such as Intelsat, Inmarsat, Intersputnik, and New Skies have been transformed from intergovernmental organizations into commercial service providers. They exert considerable influence in satcom markets. In Asia and the Pacific, there are strong regional and subregional players, such as Asia Satellite, APT Satellite and Shin Satellite. Several countries in the region, such as Australia, China, India, Indonesia, Japan, the Philippines and the Republic of Korea, have their own domestic satellites, and some of them are making the transition to the regional or subregional domains.

54. The Tampere Declaration brought several issues into focus: (a) the combined use of terrestrial and satellite communications facilities to predict, monitor, and respond to major disasters throughout the world; (b) the various mechanisms within the United Nations Disaster Relief Organization for international sharing of communication sources, training

of personnel, and coordination of disaster relief efforts; and (c) the removal of unwanted regulatory barriers to rapid dissemination of information and effective use of communication resources essential for disaster management. With the changing domains of role players, it has become possible for private industry, through United Nations agencies and also on their own, to start promoting cost-effective communication solutions for disaster management. For example, 5,000 of the 80,000 Inmarsat mobile communication terminals are used in disaster management by international organizations, including the United Nations, Red Cross and other charity agencies. The United Nations disaster response initiative "First on the Ground", in cooperation with the communications company Ericsson, is of considerable significance, because it envisages providing mobile and satellite telephone links, as well as microwave links, for humanitarian relief workers in areas affected by natural disasters and emergencies (United Nations 2000).

1. Modes of Information Dissemination: Multitasking of Satcom Networks

55. Digital divides do affect information dissemination. Usually, the floods and drought prone lack information dissemination infrastructure also. The interoperability of various communication systems including Internet, Mobile phones, fax, e-mail, radio and television is increasingly becoming functional, and the access to voice, video, and data in an interactive manner is always desirable to the user communities. Five modes of information dissemination include document/text, Internet, intranet, wireless broadcast and fixed telecommunications. Each of the five modes of dissemination has different strengths and weaknesses (Table 5). These modes complement one another. Internet offers high interactivity and high connectivity at basic cost. Intranet offers high interactivity and bandwidth for a price. Printed materials provide high reliability, high coverage at low cost (GDIN 1997).

Table 5. Modes of information dissemination

	Document	**Internet**	**Intranet**	**Wireless Broadcast**	**Fixed Telecommunications**
Security	Strong	Limited	Strong	Limited	Limited
Congestion control	N/A	Limited	Strong	Strong	GETS
Connectivity	N/A	Large	Controlled	Variable	Large
Bandwidth	Large	Shared	Medium to large	Variable	"Get-what-you-pay-for"
Cost	Low	Basic	Scalable	Inexpensiv e	Scalable
Reliability	High	Moderate	High	High	High
Interactivity	None	High	High	None	Limited

Source: GDIN, 1997. *Harnessing Information and Technology for Disaster Management*. The Global Disaster Information Network (GDIN), Disaster Information Task Force Report. November 1997. United States Department of Commerce.

56. Multitasking of satcom networks enables more than one mode of information dissemination, depending on the basic communication infrastructure in the region. The availability of broadband satellites or use of mobile VSAT networks provides the enabling infrastructure. However, the quality of services in tune with the community needs during or after floods and drought hold the key. Governmental policies and institutional arrangements facilitate such efforts.

2. Enabling Mechanisms

57. It is clear that market forces are the primary driver of space system developments. All the limitations of Earth observation pertaining to spatial resolution, value addition and product generation are addressed to a large extent. Of course, the constraints pertaining to all-weather-capability microwave data (because Radarsat-1 is nearing the end of its designated mission life, and Envisat cannot fill the gap because of its insufficient repeat cycle) may hinder some of the applications, particularly impact mapping and damage assessment due to floods. Some countries like China and India have their own airborne SAR to fill the gaps. However, it is important to recognize that Earth observation potentially drives hazard zonation and risk assessment, whereas improvements in early warning and satcom address the critical gaps related to connectivity and information dissemination.

58. It is therefore necessary that Earth observation and satcom become integrated (a) in governmental policies, (b) in the related efforts of international organizations, including the United Nations, and regional agencies, (c) in building international/regional/subregional cooperative frameworks, and (d) in the capacity-building mechanisms (Figure 5). Basically, the efforts should aim at using space applications while addressing the information needs of the stakeholders, as well as strengthening the institutional infrastructure.

Figure 5. Enabling mechanisms for harmonizing information needs of stakeholders with national systems and space applications

59. Disaster management has attracted considerable international focus. United Nations agencies, international funding agencies, donors and bilateral/multilateral cooperative mechanisms – all have attached due importance to disaster management. Reducing vulnerability to and risk from natural or man-made hazards is addressed by many entities of the United Nations system within the framework of their respective field of activities. The International Strategy for Disaster Reduction (ISDR) has been established as the successor arrangement to the International Decade for Natural Disaster Reduction (1990-2000), for a consolidated and coordinated approach to disaster and risk reduction by concerned entities within and outside the United Nations system (www.unisdr.org). ISDR, placed under the direct authority of the Under-Secretary-General for Humanitarian Affairs, is dedicated entirely to disaster reduction.

60. All the regional commissions of the United Nations – including ESCAP and the specialist agencies UNDP, FAO, UNICEF, UNEP, WFO, UN-HABITAT, UNESCO, WMO and WHO – have been making contributions in the areas of disaster management within the framework of their mandated activities. ESCAP, for example, in cooperation with WMO, conducted a regional survey, which has contributed to the strengthening of regional cooperation in flood forecasting and disaster reduction. Similarly, ESCAP provided advisory services to the secretariat of the Mekong River Commission on the formulation of the regional strategy for flood management and mitigation. The Asian Disaster Preparedness Centre (ADPC) (www.adpc.net) and Asian Disaster Reduction Centre (www.adrc.or.jp) are regional agencies working in areas related to disaster management.

61. In respect of space applications, the United Nations Office for Outer Space Affairs (OOSA), based in Vienna and linked to the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), is implementing a programme for an Integrated Space Application System for Disaster Management, in cooperation with a number of United

Nations agencies and programmes, as well as other entities such as the Committee on Earth Observation Satellites. This activity is carried out in response to the call for implementing an integrated global system capable of using space applications and space-based services for disaster mitigation, relief and prevention (UNISPACE III Conference) (www.oosa.unvienna.org). One of the remarkable achievements, as part of the UNISPACE III recommendations, has been the emergence of the International Charter "Space and Major Disasters". Recognizing the fact that no single operator or satellite can match the challenges of natural disaster management, and that a long-term working partnership between the civil protection community and space agencies holds the key for efficient use of space technology in disaster management, the International Charter is, in a sense, an important milestone towards bringing the major space agencies together in the framework of cooperation (www.disasterscharter.org).

62. FAO, through its World Agricultural Information Centre (WAICENT), develops and maintains a Website on disaster-related activities to provide access to disaster reduction information, and it has mobilized international support through its Global Information and Early Warning System (GIEWS). FAO has further enhanced its ability to provide an operational service on environmental information, through the Advanced Real-Time Environmental Monitoring Information System (ARTEMIS), which uses satellite remote sensing data. Moreover, the FAO Environment and Natural Resources Service, of the Sustainable Development Department, develops various spatial information infrastructure and databases and uses remote sensing and GIS for sustainable development planning, including disaster impact assessments and mapping of risk from and vulnerability to natural hazards (www.fao.org).

63. There may be certain overlaps among the various international efforts, but there is a thin demarcation in terms of their respective mandates, which drive the various activities. For example, in the case of ESCAP, addressing floods and drought falls under the broad umbrella of poverty alleviation and managing the negative impacts of globalization in the region. A brief analysis on the related activities is in Appendix E, which brings out very clearly the role of international organizations in disaster reduction, as well as their efforts in harmonizing the information needs of stakeholders with institutional capabilities and space systems (United Nations 2002).

VII. SPECIFIC RECOMMENDATIONS

64. To work towards harmonizing the needs of stakeholders, the institutional capabilities and the space systems, first of all, it is important to identify the potential linkages and the common threads wherein all the three players could collectively be engaged. Among the various space applications, the endeavours of developing countries on risk assessment, early warning and emergency communication provide a common ground. For the benefit of countries with constrained institutional environments, especially LDCs, it is necessary to take up the following initiatives discussed below.

A. Entry Point Activities

65. Entry point activities (EPAs), in the present context, envisage integrating the operationally demonstrated potential of space applications in areas that could attract higher

priority by the user communities, and also trigger wide-ranging related activities. Considering this, the first EPAs could involve promoting the role of Earth observation inputs in hazard zonation and risk assessment.

1. Hazard Zonation and Risk Assessment

66. Satellite imagery has important applications in mapping – including risk assessment. While 95 per cent of the world's land mass is mapped at a scale of 1:250,000, only 33 per cent is mapped at 1:25,000. Less than 20 per cent of Asia and the Pacific are mapped at higher scale. In the case of LDCs, the figures are far lower. In many cases, the maps available are outdated or incomplete. The development of risk assessment, driven by mapping activities, is hampered primarily by lack of adequate data, followed by inadequate institutional and technical capacity or resources, and little policy support in the developing countries.

67. Although there could be debates on the scale of mapping, format, standards and information content related to social, economic and ecological/climatic vulnerability, risk assessment ranks number one in terms of users' priorities. The use of remote sensing and GIS has also demonstrated their operational reliability in generating risk assessment scenarios to a certain level. At micro-level risk assessment for floods, earthquakes and landslides, some of the specific requirements – such as digital elevation model (DEM) with close contour intervals, good SAR interferometric pairs, high-resolution imaging, and the like – demands strong institutional/industry support. For drought, even the coarser levels of hazard zonation and risk assessment can serve the purpose to some extent.

68. In the simplest terms, hazard zonation and risk assessment are derivatives of other maps, such as land-cover, geological, climate and poverty maps. Land-cover maps indicate ecological vulnerability; geological maps geophysical vulnerability; climate maps climatic vulnerability; and poverty maps socio-economic vulnerability. Aggregating all these fields makes hazard zonation and risk assessment more accurate (Figure 6).

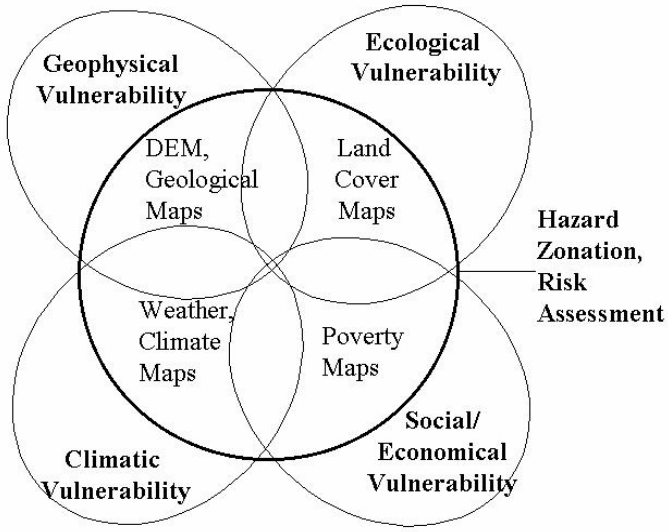


Figure 6. An approach to hazard zonation and risk assessment

69. The "best practices" in the region, relating to hazard zonation and risk assessment, have demonstrated the operational viability of this approach. For example, multi-date satellite data capturing the flood inundations during the various flood waves could be integrated with land cover, geological, climate and poverty data (based on household census and survey data) and produce risk assessments. Based on frequency of flooding, it is possible to identify those villages and vulnerable persons who live with maximum risks (Figure 7). They could be targeted for various interventions such insurance coverage, regulations and other policies.

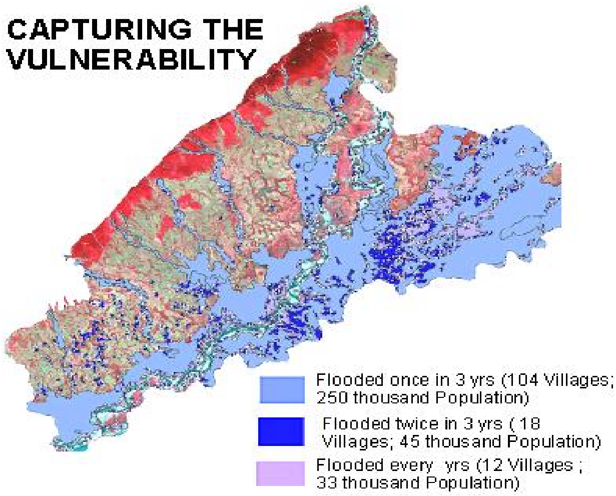


Fig. 7. Microzonation for risk assessment: Lakhimpur District, Brahmaputra Basin, India.

Figure 7. Micro-zonation for risk assessment: Lakhimpur District, Brahmaputra Basin, India

With the above backdrop, ESCAP may consider working on the following steps:

- **Development of national-level risk information capabilities:** Creating awareness, imparting training and education, facilitating the information/knowledge sharing between the member and associate member countries to encourage hazard zonation and risk assessment activities in the region. RESAP training and educational networks could be used for the specialized activities.
- **Taking up regional/subregional risk assessment projects in selected pockets of LDCs:** Like the "Asia Cover" project, a joint initiative of FAO and ESCAP, efforts could be made to launch regional and subregional risk assessment pilot projects covering the areas most vulnerable to floods and drought. Projects could be dovetailed with other contemporary missions, including Asia Cover.
- **Diversifying the scope of mapping:** In recent years, poverty mapping has attracted considerable focus. The poor in flood plains and semi-arid regions are identified with increasing vulnerability and risks. It is important to encourage the diversification of mapping activities to avoid duplication as well as to promote the multi-purpose uses of such maps.

- **Bringing out a compendium:** A compendium summarizing the "best practices" on risk assessment, highlighting operational methodologies, institutional factors and enabling applications, would be of considerable importance.

2. Strengthening Early Warning Systems

70. Taking into account the operational role that Earth observation and satcom could play in strengthening the existing early warning systems pertaining to floods and drought, the following steps may be taken up:

- **Improving hazard warning capabilities:** While there are concerted efforts in developing countries to strengthen their existing capabilities, there is still a gap in understanding the scope of space applications in such endeavours. A simple review of existing capabilities reveals that most of the early warning systems for drought and floods are based on hydrometeorological parameters. There is a need to review critically the early warning systems vis-à-vis the scope for space applications to strengthen these within the existing institutional environments of developing countries. Learning from the best practices is necessary in this regard.
- **Risk assessment to strengthen early warning:** Risk assessment maps provide the essential ingredients for locating the warning systems and targeting the vulnerability levels for disseminating the warning messages.
- **Capacity-building at local levels:** Although the early warning systems developed by international organizations, regional agencies and national governments have shown their operational reliability over the years, the weakness lies in local-level mechanisms in terms of (a) interpreting generic information into the contextual information, and (b) taking timely decisions to reduce the losses. For example, forecasters need expertise to contextualize El Niño-based seasonal drought forecast and forecasting of water level rise in the river basins. Space applications address such gaps. ESCAP, WMO and regional agencies may develop suitable enabling mechanisms to benefit the developing countries.

3. Access to Earth Observation Data and Services

71. Access to Earth observation data and services is without a doubt the real entry point activity. High-resolution data are a necessity for detailed risk assessment. The emergence of "global transparency", resulting from high-resolution commercial remote sensing satellites, promises benefits as well as costs. The challenge is to devise policies that harness the benefits of growing international transparency.

- **At the fringes of commercialization, there is a room for negotiating humanitarian causes:** In the case of satcom applications, Intelsat, Ericsson and other commercial operators have demonstrated their support through United Nations agencies and enabled emergency communication networks in the several vulnerable pockets. A similar framework may be useful in providing high-resolution imagery to LDCs – possibly for pilot demonstrations of risk assessment.
- **Replicating the Tampere Declaration:** The Tampere Convention triggered wide-ranging satcom applications for disaster management, so a similar convention may help to expand the scope of Earth observation. A suitable framework is necessary to organize such a convention.

- **Forum of Earth observation agencies for disaster management:** In the existing data distribution policies of space agencies, both in public and private sectors, there is scope for cost-effective Earth observation data access, especially for disaster management. If a forum of Earth observation agencies for disaster management is created, in the framework of cooperation and information sharing, it will help LDCs gain cost-effective access to observation data.
- **Mobilizing the support of space agencies:** Some of the space agencies, such as NOAA, have (a) rare archives of historical EO data pertaining to the typical floods and drought, (b) latest Earth observation data, information and scientific knowledge relevant to the developing countries in the region, and (c) website with valuable resources. The support from such agencies, especially in terms of capacity building in the developing countries to enable them to benefit from such resources, will help strengthening national capabilities in the region. For example, www.reliefweb.int provides valuable Earth observation inputs on the natural disasters for relief operations. To act on such information by local user's community particularly in LDCs, it is necessary to have enhanced capabilities.
- **Harnessing the benefits of Disaster Monitoring Constellation (DMC):** The DMC is gaining ground in terms of providing near real time Earth observation access to the user community worldwide. The support of the participating agencies involved in DMC will promote Earth observation applications for emergency management.
- **Cultivating International Charter support to help LDCs:** Although the "International Charter on Space and Major Disasters", a partnership effort among space-faring nations, provides users the opportunity to have free access to satellite data and services the benefits of the Charter have been limited in Asia and the Pacific region. Out of around 40 activations of the Charter since 11 November 2000, support has been extended to only about eight or nine disasters from the region.

At the ESCAP level, efforts are important to maximize the benefits from the Charter. The efforts could include the following: **(a) expanding the scope of the Charter to include hazard/risk assessment early warning and emergency communications (as the present focus of the Charter is primarily disaster impact assessment, it is desirable to accommodate disaster-mitigation-related services as well), (b) extending special privileges, in terms of capacity-building and other support, to LDCs, considering their higher degree of vulnerability and weaker institutional base, and (c) negotiating the role for ESCAP to help LDCs in the overall Charter mechanisms.**

4. Recasting Community Teleservice Centres: Prototype Demonstrations

72. Community teleservice centres (CTCs) have served the purpose of reaching out, addressing the digital divides, and empowering the community. Recasting CTCs, in the framework of community-based disaster management systems (CBDMSs) by addressing the hierarchical information needs of stakeholders, calls for multitasking of existing and planned satcom/terrestrial networks. The concept of an enhanced, deployable, disaster-response CTC with mobile communications is shown in Figure 8. The essential services like connectivity (telephone, fax, email, video, data), dissemination of warning messages, vulnerability status, community empowerment through social safety nets, tele-medicine

support, public education and training, and the like could be organized in the multitasking mode. In fact, recasting of CTCs would address several gaps in the system, such as sending out early warning messages and other related services down the line.

- **Prototype "Proof of the Concept" pilot project:** Considering that such initiatives can create wide-ranging impacts, it is necessary to conduct a pilot project based on multitasking the satcom/terrestrial networks. To start with, multitasking of mobile WLL-based VSATs could be considered.
- **Multitasking of broadband satellite networks:** The advent of broadband satellites in Ku and Ka regions holds improved potential for wide-ranging mainstream applications. Multitasking on larger bandwidths is easier than on narrow bands and may provide better emergency services. Proof of the concept in this regard will have far-reaching implications.
- **Compendium on multitasking of satcom networks for disaster management:** A compendium may serve as a valuable document for the member countries and associate members to develop awareness about the best practices and encourage them to develop political support.

Figure 8. Multitasking of an emergency communication network to facilitate a community-based disaster management system

B. Setting up Regional and Subregional Cooperative Networks for Floods and Drought

73. Recurrent floods and drought are common to several countries in different parts of Asia and the Pacific. The same river, for instance, may cause floods in more than one country. The real strategy for flood management, therefore, lies in taking into account the totality of the river basin, passing through different countries. Use of remote sensing and GIS enable the characterization of whole river basin, with all the relevant spatial attributes. Similarly, a spatial perspective of agro-ecological settings that cut across several national boundaries is required for drought management. Establishing a regional cooperative mechanism to use space applications for managing floods and drought is a manageable undertaking, and the following steps are envisaged in this direction.

- **Framework of cooperative mechanisms:** A "virtual" network could be made up, involving (a) international (i.e. United Nations) agencies and regional organizations such as the Asian Disaster Preparedness Centre (ADPC), Asian Disaster Reduction Centre (ADRC) and others, (b) space agencies, including private space-based ICT service providers such as Inmarsat, Shin Satellites, Asia Satellites, APT Satellites and others, and (c) nodal disaster management agencies, including civil defence authorities (Figure 9). **The network could focus on exchanging knowledge and experience, sharing the wisdom and perspectives of managing floods and drought, particularly in the common river basins and agro-ecological zones, integrating global knowledge and technological know-how into the local context**. **The network, while dovetailing with national initiatives, should aim at synergizing the efforts of other regional/international agencies.** The network, while it would help in integrating space applications for floods and drought, would also aim to bring synergy among the related ongoing and planned initiatives at various levels.
- **Synergy:** The network provides the opportunity to bring in synergy among the various initiatives taken up by UN agencies, other intergovernmental and regional organizations, as listed in Appendix-F.
- **Bringing disaster management and space agencies closer:** The "virtual" network aims at providing an institutional interface between conventional disaster management authorities and space agencies at international, regional, subregional and national levels. In recognizing the cross-sectoral linkages of disaster management, the focus of the work is to integrate space applications appropriately.

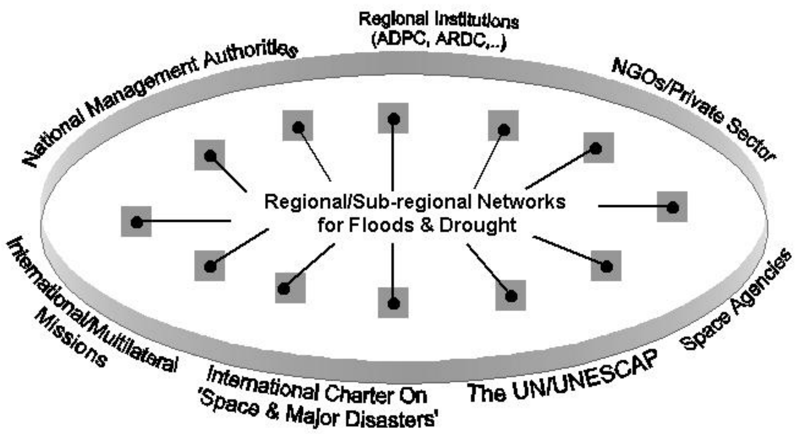


Figure 9. A conceptual framework for setting up regional and subregional networks for floods and drought

- **Strategy:** Implementing the framework is a challenging task, with the involvement of multiple agencies. However, bringing them under the umbrella of a "virtual" network involves (a) having dialogues with all the agencies, (b) working out a set of common denominator programmes and an agenda for the partnership, (c) creating a framework for synergy among the organizational activities, and (d) placing more focus on knowledge/expertise sharing than on the financial commitments. The International Charter provides insights on organizing such partnership efforts.

- **A "road map":** Regional seminars, organized jointly by ESCAP and OOSA at Beijing and Bangkok in 2001 and 2002, focused attention on the importance of regional networks (United Nations 2003). A broad framework was also spelt out. Specialized seminars and group training sessions at Singapore and Hyderabad in 2004 on floods and agricultural drought are likely to place more focus on the overall concepts of the specialized regional/subregional networks. A detailed technical document on the framework is desirable. The subsequent steps may include (a) expert consultation and dialogue with relevant players to configure the networks, and (b) consultations with member countries and associate member countries.
- **Specialized subregional network for floods:** Flood management is information intensive, so sharing the information/data holds considerable significance. In the framework of a regional/subregional network, a separate sub-network for floods could be envisaged.
- **Specialized subregional network for drought:** Managing drought involves intensive knowledge about agricultural systems, ecology of arid and semi-arid regions, soil and water conservation, cropping patterns and much more. Sharing of knowledge through sub-networks will go a long way towards reducing impacts. The FAO initiative on sharing knowledge for drought management in central, eastern and southern Asia is a good example. An ARTEMIS type of network, however, may not work in the region. In the dryland tropics of Asia and the Pacific, there are irrigation systems, diverse cropping patterns, and a different kind of indigenous coping mechanisms. Sharing knowledge through such framework seems a workable option.
- **Integration of RESAP Training and Education Networks:** Efforts could be made to integrate RESAP training and education networks to strengthen the proposed "virtual" network for floods and drought.

C. Concept Promotion

1. Convergence of Poverty Alleviation and Disaster Management: A Perspective

74. With the new paradigm in the overall disaster management approach, viz., from relief and response to vulnerability analysis to risk management, the focus is placed on the nature of people's vulnerability and the influence of poverty. In recent years, poverty alleviation and disaster reduction strategies have moved towards establishing stronger links with sectoral development.

At present, livelihood frameworks that recognize people's vulnerability context, community-based disaster management, and risk transfer and financial mechanisms are some of the approaches recognized worldwide. Such approaches are being pursued by several agencies towards integrating poverty alleviation and disaster reduction strategies (ADPC 2002). The use of space applications – particularly high-resolution remote sensing and GIS – for risk assessment at the community level, and connecting micro-level risk to the vulnerability of ecosystems helps enable the policy and institutional mechanisms to implement such approaches. It is therefore necessary to promote such concepts vis-à-vis the role of high-resolution remote sensing data therein.

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Appendix A

Natural Disasters in Member Countries (2002 Summary) (Country/Disaster Type/Disaster Characteristics)					
		Data			
Country	DisType	Count of DisNo	Sum of Killed	Sum of TotAff	Sum of Damage US$(000´s)
Bangladesh	Epidemic	1	96	49,904	
	Extreme temp	1	700	50,000	
	Flood	1	10	1,500,000	
	Wind storm	4	122	101,400	
Bangladesh Total		**7**	**928**	**1,701,304**	
Cambodia	Drought	1	0	650,000	38,000
	Flood	1	29	1,470,000	
Cambodia Total		**2**	**29**	**2,120,000**	**38,000**
China, P Rep	Drought	2	0	1,218,000	
	Earthquake	2	2	65,870	
	Epidemic	1	5	300	
	Extreme temp	1	7	3,500	
	Flood	10	1,228	113,255,696	5,236,680
	Slide	4	63	11	
	Wind storm	6	98	107,403,084	256,500
China, P Rep Total		**26**	**1,403**	**221,946,461**	**5,493,180**
India	Drought	1		300,000,000	910,721
	Earthquake	1	2	200	
	Epidemic	2	50	5,150	
	Extreme temp	2	1,930		
	Flood	6	732	42,005,250	30,772
	Wind storm	4	144	15,250	416
India Total		**16**	**2,858**	**342,025,850**	**941,909**
Indonesia	Earthquake	4	11	11,847	

	Epidemic	1	17	757	
	Flood	7	230	133,180	16,000
	Slide	1	32	5	
	Volcano	1	0	5,000	
Country	**DisType**	**Count of DisNo**	**Sum of Killed**	**Sum of TotAff**	**Sum of Damage US$(000's)**
	Wild fire	1	0	200	
Indonesia Total		**15**	**290**	**150,989**	**16,000**
Japan	Wild fire	1	0	222	
	Wind storm	3	5	100,825	
Japan Total		**4**	**5**	**101,047**	
Korea, Rep	Flood	1	20	27,507	173,224
	Wind storm	2	96	91,429	215,000
Korea, Rep Total		**3**	**116**	**118,936**	**388,224**
Kyrgyzstan	Slide	1	0	1,002	1,500
Kyrgyzstan Total		**1**	**0**	**1,002**	**1,500**
Lao, P Dem Rep	Flood	1	2	74,500	
Lao, P Dem Rep Total		**1**	**2**	**74,500**	
Malaysia	Slide	1	10		
	Wind storm	1	2	155	
Malaysia Total		**2**	**12**	**155**	
Mongolia	Drought	1			
	Wind storm	2	3	665,000	
Mongolia Total		**3**	**3**	**665,000**	
Myanmar	Flood	1	21	50,000	
Myanmar Total		**1**	**21**	**50,000**	
Nepal	Extreme temp	1	60	200	
	Slide	1	472	265,865	
Nepal Total		**2**	**532**	**266,065**	
Papua New Guinea	Earthquake	2	5	5,470	
	Epidemic	2	142	2,215	
	Slide	1	36	174	

Country	DisType	Count of DisNo	Sum of Killed	Sum of TotAff	Sum of Damage US$(000's)
	Volcano	1	0	13,000	
Papua New Guinea Total		**6**	**183**	**20,859**	
Philippines	Drought	1			453
	Earthquake	1	7	73,390	1,714
	Flood	4	85	150,567	392
	Wind storm	3	102	714,041	6,914
Philippines Total		**9**	**194**	**937,998**	**9,473**
Country	**DisType**	**Count of DisNo**	**Sum of Killed**	**Sum of TotAff**	**Sum of Damage US$(000´s)**
Russia	Extreme temp	1	242	25,062	
	Flood	4	174	336,313	507,970
	Slide	1	111		
	Wild fire	3		120	
	Wind storm	2	17		
Russia Total		**11**	**544**	**361,495**	**507,970**
Sri Lanka	Drought	1	0	557,000	
	Flood	1		500,000	
Sri Lanka Total		**2**	**0**	**1,057,000**	
Tajikistan	Earthquake	2	3	2,054	
	Flood	4	32	4,251	2,836
Tajikistan Total		**6**	**35**	**6,305**	**2,836**
Thailand	Drought	1	0	5,000,000	2,300
	Flood	2	154	3,290,920	35,827
	Slide	1	39	500,000	
	Wind storm	2	0	27,500	
Thailand Total		**6**	**193**	**8,818,420**	**38,127**
Viet Nam	Drought	1	0	1,000,000	
	Flood	3	207	1,514,816	43,500
	Wild fire	1			
	Wind storm	1	0	1,800	100
Viet Nam Total		**6**	**207**	**2,516,616**	**43,600**

Grand Total	**129**	**7,555**	**582,940,002**	**7,480,819**

In Bangladesh, epidemics, extreme temperatures, floods and windstorms occurred, and almost all of these disasters caused considerable human suffering and loss of life. The most severe disaster was the flood in 2002. It is known that Bangladesh is a path for cyclones spawned in the Bay of Bengal, making the country prone to hydrometeorological disasters.

In China, almost every type of disaster was recorded, as China encompasses a vast, heavily populated land. The most severe disasters in China in the year 2002 were floods and windstorms, followed by droughts. Also, earthquakes considerably affected the population. In 2002, the second-worst type of natural disaster in China in terms of affected population was flooding.

The year 2002 brought India's worst disaster, when the most severe drought in the world occurred and affected about 300 million people. This was the most serious disaster in the year 2002. Floods also seriously affected the people. India is located in a natural-disaster-prone area that is affected by windstorms spawned in the Bay of Bengal and the Arabian Sea, earthquakes caused by active tectonic crust activity in the Himalayan Mountains, floods brought by monsoons, and drought happening in arid and semi-arid areas.

Floods, earthquakes, and volcanic activity were the disasters that most affected Indonesia in the year 2002. These were found to be the most serious disasters in terms of affected population. Since there are seismic belts running through the country, Indonesia is an earthquake-prone country. Moreover, there are 129 active volcanoes, so volcanic eruptions often happen in the country. Floods tend to occur along with windstorms in the rainy season in Indonesia.

In Japan, the year 2002 was not as bad as previous years in terms of damage, but a significant amount of the population was affected by windstorms.

Most of the natural disasters that occur in the Republic of Korea are floods in the rainy season and windstorms. The year 2002 also recorded floods and windstorms in the Republic of Korea, and the human suffering and economic loss they caused were also quite high.

Almost 90 per cent of Kyrgyzstan is covered with mountains that are above 1,000 meters above sea level, and about 40 per cent of the mountains are in alpine areas over 3,000 m high. The distinctive natural disasters of Kyrgyzstan are earthquakes accompanied by active crustal deformation; floods caused by snowmelt, and landslides. In 2002, Kyrgyzstan also recorded slide disasters causing human suffering.

The Lao People's Democratic Republic is 95 per cent covered by mountains and its natural forests are more environmentally sound than forests in other parts of the Asian region. Furthermore, about 35 per cent of the Mekong River runs through the country. Consequently, the country is prone to floods during the rainy season. Therefore, in 2002, floods in the Lao People's Democratic Republic caused a high degree of human suffering.

In Malaysia, floods and landslides caused by rainfall during the monsoon season, and rainstorms triggered by tropical low pressure, were often recorded. The year 2002 also recorded windstorms and landslides, but the human loss and economic damage caused by these disasters was relatively small.

Mongolia is a land-locked country in Asia between Russia and China; the major disasters are *zud* (heavy snowfalls), sandstorms, floods, and so on. In the year 2002, Mongolia recorded drought and windstorms; the latter caused heavy human suffering, as the number of affected persons was high.

Myanmar is often hit by cyclones originating in the Bay of Bengal, floods in the monsoon season, and landslides triggered by rainfall. In the year 2002, floods in Myanmar had caused rather serious human suffering.

Nepal is located in the Himalayan region, where the Indian tectonic plate is wedged under the Tibetan plate; therefore, depending upon the movements and formation of the Earth's crust, earthquakes frequently occur. Floods, slides and extreme temperatures also often pose a threat to Nepal. Nepal suffered significantly in 2002 under extreme temperatures and slides, which caused heavy human loss and terribly affected many families, causing homelessness, bodily injury, disease and death.

Papua New Guinea is also highly vulnerable to many kinds of natural disasters, such as earthquakes, tsunamis, volcanic eruptions, floods and windstorms. The majority of the natural disasters that occurred in the year 2002 were geophysical disasters, and these disasters seriously affected a reasonably high number of people.

The Philippines is located on the “Pacific Rim of Fire”, making it vulnerable to both hydrometeorological and geophysical natural disasters. In 2002, as in previous years, the damage caused by hydrometeorological disasters grew, with the largest number of people affected by floods and windstorms, followed by those affected by earthquakes. Economic damage by windstorms was also noticeable.

Russia has a vast expanse of land, and the disaster-affected population and the economic losses are also quite large. Extreme temperatures, floods, slides and windstorms caused considerable human loss, and a large population was affected in the year 2002. Also, these types of disasters caused great economic losses.

Sri Lanka is located in the Indian Ocean just south of India. Droughts in the dry seasons and windstorms and floods in the rainy seasons, due to cyclones from the Bay of Bengal, are the prime concerns of Sri Lanka. In 2002, Sri Lanka was severely damaged by drought and floods, and the population affected by these disasters was quite large.

Tajikistan's prime concerns are earthquakes and floods, as mountains cover a majority of the land. So earthquakes and floods are the major threats to the country. In 2002, earthquakes and floods occurring in Tajikistan caused human suffering.

Thailand is highly prone to natural disasters because of its location and terrain. The north-eastern area is prone to floods and drought, and the south has storms, floods and slides. Thailand was severely hit by these disasters in the year 2002, and the percentage of the population affected by hydrometeorological disasters was quite high for the Asian region.

Viet Nam is located in the southeast monsoon climate area, so the majority of the annual rainfall is in the rainy season, which causes heavy human and economic loss every year. Drought, floods and windstorms caused severe human suffering and loss in Viet Nam in 2002 as well.

It may be concluded from to the above tables that the majority of Asian Disaster Reduction Centre (ADRC) member countries in the Asian region suffered from hydrometeorological disasters, which inflicted heavy human and economic loss on society and hindered economic development. Further, the heavy effects of disasters on the population deprived people of socio-economic advancement, thus slowing national and regional development. The most severe disasters in the world in 2002 were in the Asian region (Bangladesh, China, India and Thailand), affecting a great number of people in the region. Hence, it is imperative to design and implement proper disaster mitigation and preparedness plans to reduce human and economic loss and human suffering, thus contributing positively to global sustainable development.

***Source*: www.ardc.or.jp**

Appendix B

Disaster Management Information Systems (with Reference to Floods and Drought) in Selected Countries of Asia and the Pacific

1. Indonesia

Indonesia Disaster Management Information System (SIPBI)

Developed by the National Disaster Management Coordinating Board (Bakornas PB) with support from UNDP, SIPBI is aimed at enhancing Bakornas PB's decision-making capability through reliable and up-to-date information support during natural disasters – including floods and drought.

SIPBI has been responsible for (a) formulating concepts and designs, (b) establishing operational mechanisms (presently on a pilot basis at the national level and in four project areas), (c) standardizing disaster management information/data, (d) formulating standard operating procedures for system operations, and (e) facilitating development of similar systems in other disaster-prone districts and provinces.

SIPBI has been instrumental in (a) development of a computer networking system, (b) development of databases for disaster management and (c) development of geographic information system (GIS) for disaster management. The GIS component aims at developing risk maps at the national, provincial and district level. The maps, at national (1:500,000) and provincial (1:250,000) levels, are used to determine priority provinces and areas for disaster management activities and planning and for installation of early warning systems. The district-level maps (1:50,000) are used for district contingency planning (http://www.bakornaspb.or.id).

2. India

Vulnerability Atlas of India

In 1997 the Ministry of Urban Affairs and Employment, Government of India, constituted an expert group to prepare a "vulnerability atlas" taking into account the three natural hazards that are the most common and damaging to India, namely earthquakes, cyclones and floods. The map zones are at a macro level because maps of the three hazards are available at a small scale for areas all over the country. To make this information readily available to planners, administrators and disaster managers, these maps were prepared at a relatively coarse scale, state-wise, showing all the administrative units, particularly the district boundaries, for easy identification of the areas covered by the zones of various intensity levels. The Vulnerability Atlas contains the following information for each state and union territory of India:

- Seismic hazard map
- Cyclone and wind hazard map
- Flood-prone area map
- Housing stock vulnerability table for each district, indicating for each house type, the level of risk to which it could be subjected some time in the future.

The Vulnerability Atlas has been providing an important input into state-level disaster management planning.

3. Philippines

The National Disaster Coordinating Council (NDCC) is the highest policy-making body in disaster management in the Philippines. In 2000, NDCC started installing an Emergency Management Information System that will link up all their regional centres electronically and make available vital information to the public through the Internet. The system has four components: Emergency Reporting and Monitoring, Emergency Logistics Management, Emergency Fund Management and Geographic Information System. The Advanced Geographic Information Display System has been established at the Philippines National Disaster Management Centre in Camp Aguinaldo, Manila. It is linked to all member organizations of the NDCC as well as the regional offices of the Office of Civil Defence, which form the Secretariat of the Regional Disaster Coordinating Councils. The integrated database, which comprises spatial information, such as digitized maps, aerial photos and satellite data, while the non-spatial data on display covers a history of disasters, demographic databases, response teams, and a directory of key contacts and resources. NDCC is also assessing the existing systems for early warning to identify areas for upgrading and enhancement.

4. Viet Nam

The main disaster coordination body in Viet Nam, the Central Committee for Storm and Flood Control (CCSFC), is located in the Department of Dyke Management and Flood and Storm Control in the Ministry of Agriculture and Rural Development. Its Standing Office, the SOCCFSC, is the agency with the main responsibility for monitoring the effects of storms and floods, gathering damage data, providing official warnings, and coordinating and implementing disaster response and mitigation measures. It relies on the administrative structure of the Dyke Department to carry out its disaster assessment, disaster reporting, and emergency coordination duties. When a flood or storm occurs, the district-level officials are responsible for sending a district disaster assessment report to the provincial level, which collates and verifies them and forwards them to SOCCFSC, which in turn collates the provincial reports to produce a national damage assessment report. To expedite the transmission of this information, SOCCFSC has set up a disaster communication system, an emergency electronic mail network that links provincial Dyke Department offices with SOCCFSC. The disaster communication system was started in 1995, and by late 1998 was extended to every province in Viet Nam.

The Government of Viet Nam put in a large portion of its own funding, with additional funding received from UNDP, the Government of Luxembourg and Statoil Alliance. The system operates 24 hours per day, 365 days per year, and has become the official, obligatory mechanism for transmitting disaster damage and needs data to SOCCFSC. It is also used to issue disaster prevention or mitigation directives to its staff in the field, i.e. the provincial Dyke Department officials and district dyke monitors. The system was used effectively in recent flood seasons as a tool for gathering damage data.

SOCCFSC has created a department-wide Intranet, accessible both to central disaster management authorities and to officials in the localities in Viet Nam, with the assistance of the UNDP Disaster Management Unit in Hanoi, to serve as a general reference tool for disaster managers in their day-to-day work.

To make disaster information available to the public, the SOCCFSC mechanism for this has been Internet Web technology. With the help of the Disaster Management Unit, SOCCFSC maintains a bilingual, Web-based public information system to encourage information sharing by all sectors, and it disseminates key information on disaster management to the aid community.

This disaster management Website has also developed the prototype for the SOCCFSC Intranet, which contains more detailed, strictly internal information and documents used by the SOCCFSC and the Dyke Department in their daily operations. A link is also established for SOCCFSC's automatic receipt of the hydrometeorological inputs on vital flood and typhoon forecasts. The forecasts are received up to four times per day and form, along with SOCCFSC's computerized mathematical models of discharges from major reservoirs, the basis of SOCCFSC's disaster warning work. The official hydrometeorological reports, based on which the SOCCFSC sends official directives via the disaster communication system to its staff in the field, are posted on the Website. For that matter, the SOCCFSC supplements the official hydrometeorological bulletins with forecasts, satellite images, and graphics downloaded from the Internet (notably from the Websites of the American Joint Typhoon Warning Centre and from the Regional Office of the World Meteorological Organization in Japan).

The development of the UNDP Disaster Management Unit, based on a GIS database, is organized to support the decision-making processes. By producing thematic hazard and vulnerability maps using selected variables (economic value, population, flood risk, and age of infrastructure, for example), the GIS-based models are used to identify risk areas and clarify how best to respond to or to mitigate the risk of disaster. Similarly, the GIS databases are used to assess the damage due to the disasters, which makes it easier for international organizations and Viet Nam decision makers to target disaster relief aid (http://www.undp.org.vn/dmu).

5. Sri Lanka

Under the Ministry of Social Services (MOSS), Sri Lanka has established a disaster management information system called the Social Management Information System (SOMIS). The National Disaster Management Centre (NDMC) of Sri Lanka is developing a database that will incorporate various aspects of disaster management integrated with SOMIS, and the software will be compatible with commonly used operating platforms.

Appendix C

Summary of Operational Earth Observation Applications in Flood and Drought Management

Disaster	Deliverables	Turn-Around Time	Potential Use
Flood	Flood inundation map	T + 24 hours	Relief and rehabilitation
	Flood damages - Extent of inundation - Crop area affected - Villages marooned - Road/railway network affected	T + 4 days	
	Flood control works River configuration Bank erosion Identification of chronically flood-prone areas Floodplain zoning	One-time job, with an update after every major event	Strengthening of existing works and planning of future flood control works Hazard zonation and floodplain regulation
Drought monitoring and early warning	Fortnightly drought condition assessment at district level for entire country Monthly drought condition assessment at subdistrict level for selected states Integrated land and water mgmt.	Fortnightly/ monthly scale	Planning contingency measures Drought mitigation programmes

FLOODS

Management Phases	Information Needs	Space/Airborne Inputs	End-Users and Potential Use of Space Inputs
Mitigation and preparedness	Vulnerable areas Drainage network and flow	Close-contour data from airborne ALTM surveys for flood-plain zoning Use of Data Collection Platforms (DCPs) for observations from remote areas River migration studies using multi-date satellite data for flood-protection measures Use of advanced flood forecast models with satellite inputs on land use, terrain, geomorphology etc.	(i) Use of close-contour data for flood zoning (ii) Real-time data collection on water level/rainfall in major basins, using DCPs (iii) Upgrading of current flood forecast models to use satellite inputs (iv) Improved communication links for data collection (i) Use of river migration data for flood protection planning (ii) Regulations on use of flood plains for developmental activities
Response	Rainfall in catchment areas Water level in rivers and streams Run-off prediction	Monitoring/mapping of flood-inundated areas Damage assessment of agricultural crops Marooned villages	(i) Use of flood inundation information for planning rescue/relief operations (ii) Use of damage estimates for preparation of relief based on flood

Management Phases	Information Needs	Space/Airborne Inputs	End-Users and Potential Use of Space Inputs
	Terrain relief and slope Extent of affected areas Damage assessment		damage and impact
Recovery	Flood resilient land use Drainage structures Long-term measures for flood reduction	Identification of safe areas for rehabilitation Locations for flood-protection measures	For implementation of (i) regulations in flood plains, (ii) flood protection measures, and (iii) optimal rehabilitation site selection.

DROUGHT

Management Phases	Information Needs	Space-Based Inputs	End-Users and Interface Needs
Mitigation and preparedness	Vulnerable areas History of recurrence and intensity	Monitoring of crop condition using NDVI data from satellites Integrated surveys for combating drought on a long-term basis	Agriculture Department, for planning mitigation measures to combat drought
Response	Rainfall anomalies and vegetation condition assessment Areas affected and severity Assessment of damage	Assessment of likely damage and yield loss to crops	For updating information on drought situation and planning relief measures
Recovery	Drought-combating / drought-proofing measures Soil conservation measures Water harvesting schemes	Long-term planning of drought combating measures (soil and water conservation, check dams, water harvesting structures, groundwater development)	For long-term measures to achieve drought-proofing

Appendix D

Selected Commercial and Civilian Imaging Satellites

North America

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
Landsat-5	1984	EOSAT/ Space Imaging	30MS/80MS	185/185	16	Operational
Ikonos-2	1999	Space Imaging	0.82-1PAN/4MS	3/15	3 to 5	Operational
QuickBird-1	2001	DigitalGlobe	0.61PAN/4MS	22/22	1 to 5	Operational
OrbView-3	2003	OrbImage	1MS/4MS	8/8	3	Planned
OrbView-4	2000	OrbImage	3PAN/4MS/8 HS [b]	8/8/5	3	Planned
Radarsat-1	1995	CSA	8SAR	50-500	3 to 24	Operational
Radarsat-2	2004	MDA	3SAR	50-500	3 to 25	Planned

Russia

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
SPIN-2 [a]	Periodic [b]	Russia	2PAN/10PAN	180/200	N/A	N/A
Resurs-F	Periodic [c]	Russia	5-BMS/15-BMS	N/A	N/A	N/A
Resurs-DK	2000	Russia	2PAN/3MS/3SAR	N/A	N/A	N/A

[a] SPIN-2 is the product of KVR-1000 and TK-350 cameras on board the Kometa spacecraft.
[b] SPIN-2 satellites are presently launched about once each year and have a mission life of 45 days.
[c] Resurs-F satellites are launched throughout the year and have a mission life of 25 days.

Western Europe

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
SPOT-4	1988	Spot Image	10PAN/20MS	60/60	1 to 4	Operational
SPOT-5	2002	Spot Image	2.5PAN/10MS	60/60	1 to 5	Operational
ERS-1	1991	ESA	30-50 SAR	100-500	3 to 35	Operational
ERS-2	1985	ESA	30-50 SAR	100-500	3 to 35	Operational
Envisat-1	2001	ESA	30 SAR	100	3 to 35	Operational

South-East Asia and South America

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
ALOS-1	2003	Japan	2.5PAN/10MS/10SAR	70/70/70	46	
Info-Collectic	2003	Japan	1PAN/3SAR	N/A	N/A	
Kompsat-1	1999	Republic of Korea	10PAN/20MS	40/40	2 to 3	Operational

Kompsat-2	2003	Republic of Korea	3PAN/4MS	N/A	2 to 3	Planned
Rocsat-2	2002	Taiwan Province of China	2PAN	N/A	1	Planned
CEMD	2003	China	4SAR	700	N/A	Operational
CBERS-1	1999	China and Brazil	20MS/80-160MS	120/120	26	Planned
SABIA	2003	Brazil and Argentina	6MS	400	N/A	

Australia

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
Aries	2003/04	Australia	10PAN/30MS	15/15	6 to 7	Planned

Middle East

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
EROS-A1	2000	WIS	1.8PAN	13	2 to 3	Operational
EROS-A2	2000	WIS	1.8PAN	13	2 to 3	Operational
EROS-B1	2001	WIS	0.8PAN	13	2 to 3	Operational

South Asia

Satellite	Launch	Operator	Capability (m)	Swath Width (km)	Revisit Time (d)	Status
IRS-1C	1995	India	5PAN/23 MS	70/250	5 to 24	Operational
IRS-1D	2007	India	5PAN/23MS	70/150	5 to 24	Operational
IRS-P5 [a]	2004	India	2.5PAN	30	5 to 25	Planned
IRS-P6 [b]	2003	India	5PC/23MS	750/750	5-24	Operational
Cartosat-2	2003	India	1PAN	N/A	N/A	Planned
RISAT	2006	India	5-30 (SAR)	100-700	5-21	Planned

[a] IRS-P5 is also known as Cartosat-1.
[b] IRS-P6 is also known as Resourcesat-1.

Appendix E

Earth observation capabilities for information support for hazard zonation and risk assessment

Imaging Sensors		Mapping Scale	Minimum Detectable Size	Deliverables	Potential Decision Support
Reconnaissance resolution (~100W M to 1.0 km)					
NOAA-14/15	AVHRR	1:250,000	3.3km x 3.3km	Broad reconnaissance-level terrain and ocean colour information	Policies: - Broad ecological zonation, capturing ecosystem dynamics and change detection - Livelihood support for fishermen and farmers - Rapid mapping for disaster impact assessment
SPOT-4/5	VEGETATION	1:250,000	3.5km x 3.5km		
IRS-1C/1D	WiFS	1:250,000	564m x 564m		
OrbView-2	SeaWiFS	1:250,000	3.4km x 3.4km		
IRS-P4	OCM	1:500,000	1.1km x 1.1km		
Terra	MODIS	1:500,000	750m x 750m		
Moderate resolution (~10 m to 30 m)					
Landsat-7	ETM	1:25,000	45m x 45m	Systematic mapping and terrain information generation for a national survey	- National and regional planning - Ecological boundary delineation
SPOT-4	HRV-XS	1:50,000	60m x 60m		
ERS-1/2	AMI	1:50,000	78m x 78m		
IRS-1B	LISS-I	1:50,000	218m x 218m		
	LISS-II	1:50,000	109m x 109m		
High resolution (~4 m to 10 m)					
SPOT-4	HRV-PAN	1:25,000	30m x 30m	Large-scale mapping, urban mapping, input to cadastral surveys	Interventions/implementation: - Utilities and local area planning - Cartographic mapping and infrastructure development - Poverty mapping - Hazard zonation
IRS-1C/1D	PAN	1:10,000	15m x 15m		
Radarsat	SAR	1:25,000	15m x 15m		
Ikonos	Multispectral	1:10,000	12m x 12m		
QuickBird	Multispectral	1:8,000	7.5m x 7.5m		
Very high resolution (better than 2 m)					
EROS-A1	CCD Camera	1:10,000	6m x 6m	Urban cadastres and precision applications	Interventions/implementation: - Facilities management and precision applications - Disaggregated poverty mapping - Micro-level vulnerability and risk assessment - Community disaster management support
Ikonos	Panchromatic	1:2,400	3m x 3m		
QuickBird	Panchromatic	1:2,400	2m x 2m		
SPOT-5	HRS	1:5,000	3m x 3m		

Appendix F

Initiatives of International Organizations (Including United Nations Agencies) Related to Disaster Reduction (Including Floods and Drought)

Plan of Implementation	Initiatives and Programmes in Support of the Implementation of the Action	
	Organization(s) Involved	**Initiatives/Programmes**
Goal: Protecting and managing the natural resource base of economic and social development		
An integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, is an essential element for a safer world in the 21st century. The actions below are required at all levels:	ISDR Framework (IATF + Secretariat) and networks	ISDR Secretariat and Task Force work programme (Milestone event: Second World Conference on Disaster Reduction, January 2005, Kobe, Japan)
	WMO	- Natural Disaster Reduction in Coastal Lowlands - Natural Disaster Prevention and Mitigation Programme
(a) Strengthen role of ISDR and encourage the international community to provide the necessary financial resources to its Trust Fund;	ISDR Framework (IATF + Secretariat)	ISDR Support Group, United Nations General Assembly (Milestone event: Second World Conference on Disaster Reduction, January 2005, Kobe, Japan)
(b) Support the establishment of effective regional, subregional and national strategies and scientific and technical institutional support for disaster management;	**ASEAN, ADPC**	**Development of ASEAN Regional Programme on Disaster Management**
	MRC, ADPC	**MRC Flood Management Programme and Capacity-Building for Flood Contingency Planning**
	OOSA	**Space Technology and Disaster Management Programme (STDM)**
	ESCAP, WMO, Typhoon Committee, Panel on Tropical Cyclones, and ADPC	- Strengthen regional cooperation by improving subregional strategic cooperation plans and their implementation. - Development of pilot projects on risk mapping, early warning and community-based disaster management
(c) Strengthen the institutional capacities of countries and promote international joint observation and research, through improved surface-based monitoring and increased use	**Government of Bangladesh, USAID, PAOS, ADPC**	**Development and implementation of “Climate Forecasting Applications in Bangladesh Programme”**

of satellite data, dissemination of technical and scientific knowledge and the provision of assistance to vulnerable countries;	NOAA, USAID/OFDA, ADPC, governments of Indonesia, the Philippines and Viet Nam	Reducing vulnerability to climate variability and extreme climate events.
	OOSA	STDM
	GFMC Global Terrestrial Observing System (GTOS)	Global Wildland Fire Network through the Regional Wildland Fire Networks, Global Observation of Landcover Dynamics (GOFC/GOLD) (fire mapping and monitoring activity)
	UNESCO, ESA, IGOS	IGOS Type II Partnership on space applications to combat the negative impact of natural disasters
	ESCAP, WMO, Regional Working Group, Typhoon Committee, and Panel on Tropical Cyclones	**Applications of meteorological satellite data and information products for sustainable development**
	ESCAP, China, France, India	**Project on capacity-building for disaster management in Asia and the Pacific (space technology application and regional cooperative mechanisms in managing flood and drought)**
(d) Reduce the risks of flooding and drought in vulnerable countries by, *inter alia*, promoting wetland and watershed protection and restoration, improving land-use planning, improving and applying more widely techniques and methodologies for assessing the potential adverse effects of climate change on wetlands, and, as appropriate, assisting countries that are particularly vulnerable to these effects;	Mekong River Commission (MRC), ADPC	MRC Flood Management Programme: Land Use Management
	OOSA	STDM
	ESCAP, WMO, Typhoon Committee and Japan	**Integrated Flood Hazard Mapping Pilot Projects (to be funded by Typhoon Committee members and Japan)**
	ESCAP, ISDR, UNDP, UNCCD Secretariat and ADPC, GEF	**Regional Drought Preparedness Network for Asia**
(e) Develop integrated water resource management programmes for mitigating the effects of extreme water-related events.	**ESCAP**, WMO and Typhoon Committee	**Typhoon Committee's Regional Cooperation Programme Implementation Plan for Disaster Prevention and Preparedness; Flash Floods and Sediment Disaster Warning Pilot Projects**
	UNESCO	World Water Assessment Programme (WWAP)
	ESCAP, UNDP and ECLAC	**Assessment of socio-economic impacts of hydrometeorological disasters in Asia and the Pacific**
	USAID, NOAA, ADPC	ADPC Extreme Climate Events Programme

Goal: Poverty eradication Combat desertification and mitigate effects of floods and drought, through improved use of climate and weather information and forecasts, early warning systems, land and natural resource management, agriculture practices, and ecosystem conservation. Find predictable sources of financing. Such efforts are particularly important in Africa.	USAID, NOAA, ADPC, governments of Indonesia, the Philippines and Viet Nam	ADPC Extreme Climate Events Programme
	African Union	Environmental rehabilitation (rangeland and forest) project in Kassala State, Sudan
	GFMC	Global Wildland Fire Network through the Regional Wildland Fire Networks: - Organization of the International Wildland Fire Summit (8 October 2003)
Strengthen the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa. This would include the following actions at all levels: (a) Integrate measures to prevent and combat desertification as well as to mitigate the effects of drought through relevant policies and programmes; (b) Provide affordable local access to information to improve monitoring and early warning related to desertification and drought;	ADPC	Dialogue on drought mitigation at the third Meeting of the ADPC Regional Consultative Committee on Disaster Management
	African Union / UNCCD	Transboundary land degradation and desertification control in the Sahel-Maghreb border region
(c) Improve techniques and methodologies for assessing effects of climate change, and encourage the continuing assessment of these adverse effects by the Intergovernmental Panel on Climate Change;	GFMC	- International Geosphere – Biosphere Programme (IGBP) - International Atmospheric Chemistry Project (IGAC) - Biomass Burning Experiment (BIBEX)
(d) Take steps to reduce negative impacts of climate change;	WMO	World Climate Programme: - Climate Information and Prediction Services Project (CLIPS)
(e) Encourage the dissemination and use of traditional and indigenous knowledge to mitigate the impact of disasters, and promote community-based disaster management planning by local authorities, including training activities and raising public awareness.	ADPC, Countries of South and South-East Asia	- Community-Based Disaster Management (CBDM) training - Urban Disaster Mitigation training and programmes - Disaster Risk Communication Programme in Cambodia, Lao People’s Democratic Republic, and Viet Nam
	ESCAP, ADPC, Typhoon Committee, Panel on Tropical Cyclones	**- Sharing of experience on community-based flood forecasting pilot projects (to be funded by the Typhoon Committee)** **- Implementation of phase 2 of community-based disaster management projects (expected to be funded by European Union)**

	GFMC	Multi-stakeholder National Roundtables on Fire Management to facilitate participatory and community-based principles, including traditional and indigenous knowledge on fire and wildland prevention
Goal: Urban poverty eradication Achieving the goal of "cities without slums": Construction of adequate and secure housing for the poor, taking into account climate, specific social conditions, and vulnerability to disasters (urban risk reduction).	ADPC	Asian Urban Disaster Mitigation Programme
	United Nations/HABITAT	Risk and human settlement initiatives: - Consultation on "Disaster reduction at the urban local level"
	ICLEI, ISDR, UNESCO, United Nations/HABITAT, NGOs	Resilient communities Type II partnership
Improve policy-making and decision-making at all levels through, *inter alia*, improved collaboration between natural and social scientists, and between scientists and policy makers, including the following actions at all levels: (a) Increase the use of scientific knowledge and technology, and increase the beneficial use of local and indigenous knowledge in a manner respectful of the holders of that knowledge and consistent with national law; (b) Make greater use of integrated scientific assessments, risk assessments and interdisciplinary and intersectoral approaches;	United States/NOAA, ADPC, meteorological departments of ASEAN countries	Asian Climate Training, May 2002

(c) Support the on-going voluntary contribution of, as appropriate, NGOs, the scientific community, and other partners in the management of natural disasters according to agreed, relevant guidelines;	IFRC	Risk, Vulnerability and Capacity Assessment (VCA)
(d) Develop and strengthen early warning systems and information networks in disaster management;	ISDR framework and Government of Germany	Early Warning Type II Partnership: Working Group II of IATF on Early Warning led by UNEP (Milestone event: Second International Conference on Early Warning, 16-18 October 2003, Bonn, Germany)
	ASEAN, ADPC	ASEAN Disaster Information and Communication Network

	OOSA	STDM
	GFMC	Global Wildland Fire Network through Regional Wildland Fire Networks
(e) Promote the access and transfer of technology related to early warning systems and to mitigation programmes to developing countries affected by natural disasters.	GFMC	GFMC Global Wildland Fire Early Warning and Monitoring system
Support efforts to prevent and mitigate the impacts of natural disasters, including these actions at all levels: (a) Provide affordable access to disaster-related information for early warning purposes; (b) Translate available data, particularly from global meteorological observation systems, into timely and useful products.	GFMC	Free access to the GFMC global wildland fire information system: a Web portal for wildland fire early warning, monitoring and support for strategic fire management planning
Develop and strengthen capacity at all levels to collect and disseminate scientific and technical information, including the improvement of early warning systems for prediction of extreme weather events, especially El Niño/La Niña, through the provisions of assistance to institutions devoted to addressing such events, including the International Centre for the Study of the El Niño phenomenon.	WMO with support of ISDR and Government of Ecuador	- Establishment of International Research Centre on El Niño (CIIFEN) (regular El Niño monitoring and outlooks) - Working Group I of ISDR IATF on Climate and Disasters, led by WMO
	OOSA	STDM
Promote cooperation for the prevention and mitigation of, preparedness for, response to and recovery from major technological and other disasters with an adverse impact on the environment, in order to enhance the capabilities of affected countries to cope with such situations.	Joint OCHA/UNEP Environment Unit, Environmental Emergency Services (EES), and the Advisory Group on Environmental Emergencies (AGEE)	WSSD partnership on an Integrated Approach to Prevention, Preparedness for and Response to Environmental Emergencies in Support of Sustainable Development
	OOSA	STDM

Goal: Sustainable development of small island developing States (SIDS)		
Extend assistance to small island developing States in support of local communities and appropriate national and regional organizations of small island developing States for comprehensive hazard and risk management, disaster prevention, mitigation, and preparedness, and help relieve the consequences of disasters, extreme weather events and other emergencies.	**ESCAP**, ESA, CNES, OOSA	**Regional cooperation on the use of space technology for disaster management for Pacific Island Countries (to be funded by ESA)**
	United Nations/DESA/CSD	Disasters and vulnerability to be the main issues of fifth cycle (2014-2015)