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Implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III)

Implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III): final report of the Action Team on Disaster Management

Note by the Secretariat

I. Introduction

1. The Action Team on Disaster Management is one of the 12 action teams established by the Committee on the Peaceful Uses of Outer Space to implement priority recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). Specifically, the Action Team was tasked to investigate the implementation of an integrated, global disaster management system. The terms of reference of the Action Team are contained in the annex to the present report.

2. The present report consists of four sections, setting out the background to the establishment of the Action Team; the process and activities of the Action Team to accomplish its work; the results of its work; and recommendations on the concept and implementation of a global disaster management system. A more detailed report will be prepared by the Action Team subsequently.

3. The present report draws on information provided in various documents prepared by the Action Team, including studies, activity reports, minutes of

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meetings, presentations and summaries of discussions, which are available at the web site of the Office for Outer Space Affairs (www.oosa.unvienna.org/unisp-3/followup/action_team_07/index.html).

II. Background

A. Establishment of the Action Team

4. At its thirty-eighth session, the Scientific and Technical Subcommittee endorsed the agreement of its Working Group of the Whole to establish an expert group to study the implementation of an integrated, space-based, global natural disaster management system. The expert group was established with core members from countries possessing advanced scientific and technological capability or which were highly vulnerable to disasters. The Subcommittee agreed that the Chairman of the expert group would be elected by its members and that the election would be subject to approval by the Committee on the Peaceful Uses of Outer Space at its forty-fourth session, in June 2001 (see A/AC.105/761, para. 29 and annex II, para. 10).

5. At its forty-fourth session, the Committee on the Peaceful Uses of Outer Space agreed to establish action teams composed of interested Member States in order to implement the recommendations of UNISPACE III that had been accorded the highest priority or for which an offer had been received from Member States to lead the associated activities. The Action Team on Disaster Management was established based on that agreement, with the membership of the expert group being subsumed into the Action Team.

6. Canada, China and France had presented to the Committee at its forty-fourth session their candidatures for leading the expert group. The candidatures were formally accepted by the Action Team at its first plenary meeting, held on 5 and 6 October 2001 during the fifty-second International Astronautical Congress in Toulouse, France. At that meeting, the Action Team agreed that its chairmanship would be shared by those three countries. The work of the Action Team was coordinated by the Scientific and Technical Subcommittee, with the assistance of the Office for Outer Space Affairs of the Secretariat.

7. In accordance with the resolution adopted at UNISPACE III entitled "The Space Millennium: Vienna Declaration on Space and Human Development",[1] the mandate of the Action Team relates to the implementation of an integrated, global system, especially through international cooperation, to manage natural disaster mitigation, relief and prevention efforts through Earth observation, communications and other space-related services, making maximum use of existing capabilities and filling gaps in worldwide coverage. It was felt that today's space technologies could make a difference in such efforts if proper structures, systems or modus operandi could be envisaged and implemented. The Action Team was tasked to analyse the current situation and to provide views and proposals on the initiatives to be taken in order to bring the benefits of space-derived information to all countries suffering from disasters. Membership of the Action Team was open to all interested Member States, entities of the United Nations system and organizations that had observer status with the Committee on the Peaceful Uses of Outer Space. Other entities that

were supporting the activities of the Office for Outer Space Affairs in its activities relating to disaster management also participated in the Action Team.

B. Space and disaster management

8. The management of natural disasters is often beyond the scope of ground-based capabilities and investing space technologies in disaster relief and mitigation is therefore well justified. Because of the inevitable occurrence of natural phenomena, exacerbated by global environmental change, aggravated ecological imbalances, the growing world population, inappropriate human practices in terms of land use and land development and increasing pressures on other resources of the Earth, disasters are occurring more frequently and their consequential damage is increasing. That situation, in turn, is causing deforestation, desertification, soil erosion, water deficit, poor health and an impoverished quality of life, all of which inhibit sustainable development. The toll caused by natural disasters has many components, including human casualties, destruction of livestock, crops, forests and assets, interruption of communications and power supplies, damage to health and security services and operational losses owing to disruption in production, trade and transportation.

9. The International Federation of Red Cross and Red Crescent Societies has calculated that, over the last decade, the cost attributed to natural disasters amounts annually, on average, to over 60,000 human lives lost, almost 250 million lives affected and damages estimated at $70 billion. In general, while the actual number of human losses to disasters appears to be decreasing slowly over time, the number of people affected by disasters is increasing.[2] Human loss and hardships are higher in countries already suffering from low human development and income levels. The effects of disasters on such countries are more severe and longer lasting, compared to countries that are economically better off, where greater investment is made in preparedness and losses are predominantly financial, in particular for settlement of insurance claims, and related to property and infrastructure damage, rather than loss of life. The relative economic development and general income level of a country is also a determining factor in the length of the recovery period. The most serious type of disaster varies from country to country, depending on each country’s vulnerability based on its geographical location and the degree of investment in preparedness.

10. During the past decades, enormous progress has been made in the scientific understanding of the various natural phenomena on the planet, on the land, in the oceans and in the atmosphere. Space technologies and systems are making important contributions to this understanding. Many events that were perceived in the past as being erratic and inevitably fatal, such as volcanic eruptions, earthquakes, tsunamis and cyclones, among others, are now much better understood and their manifestation is becoming more predictable.

11. Space systems provide a global view of the planet. They provide excellent tools to observe and monitor natural disasters and to help model their evolution. They also have the unique capability to allow for global and detailed observation of an area devastated by a disaster, thus facilitating efforts to assess the situation and providing guidance to the authorities in charge of civil protection and relief. The

benefits that space systems can provide should consequently be made available to all countries as soon as possible.

12. A clear advantage was therefore seen in the initiative that followed UNISPACE III in the area of disaster management, for both the advanced countries that offer space-based tools and technologies and for the less developed nations that are least prepared to cope with disasters on their own.

III. Activities

13. The Canadian, Chinese and French co-chairs presented a three-year work plan to the first plenary meeting of the Action Team for approval. The work plan followed the directions provided by the Scientific and Technical Subcommittee and envisaged a phased approach to fulfil the mandate of the Action Team. The Team was required to carry out related studies and to propose a plan for a global disaster mitigation and management system or systems that would fully utilize existing space and ground resources, including those of the United Nations system. The Action Team was also required to suggest ways to maintain a sustainable development of existing disaster mitigation systems.

14. The Action Team conducted its business through its regular plenary sessions and task-oriented working groups. In addition, the three co-chairs held regular discussions by means of conference calls and with the full support of the Office for Outer Space Affairs. The proceedings of the plenary meetings of the Action Team were recorded in minutes, which were reviewed by the Action Team and distributed to its members in a timely manner. A total of six plenary meetings have been held to date, once each in Toulouse, France, Houston, Texas, United States of America and Bremen, Germany, and three times in Vienna. The annex to the present report includes a list of countries and organizations that participated in the work of the Action Team.

A. Survey of needs, capacities and systems

15. The main challenge for the Action Team was to relate information on available space technologies to the needs of the user communities, which had a varying degree of experience in, and knowledge of, space technologies. A broad-based consultative process was followed in order to collect information on the needs of countries for managing disasters and on the resources available to the countries to meet those needs. The Action Team conducted a global survey on user needs and national capacity, using standard forms. The Action Team also compiled an inventory of existing space systems that had capabilities believed to be relevant to disaster management. Based on the information received or provided by relevant studies that had been previously conducted and were available, the usefulness or adequacy of the available space technologies for disaster management could be assessed. The results of the survey and its subsequent analysis are described below.

1. User needs

16. The replies to the survey covered a wide variety of disasters: floods, droughts, earthquakes, mud and rock flows, landslides, forest fires, volcanoes, ocean storms,

desertification, nuclear emergencies, ocean surges, oil spills, marine pollution, avalanches, plant disease and insect pests. Some types of disaster, such as floods, forest fires and ocean storms (cyclones and typhoons), were included in the replies of nearly all the countries that participated in the survey. Other types of disasters, such as haze, plant disease, insect pests, avalanches, nuclear emergencies, marine and water pollution and ice hazard, were unique to certain countries. Some other types of disaster, such as oil spills, were also commonly included in the replies to the survey, especially by oil exporting and industrialized countries. The key findings are summarized below by type of disaster. The Action Team prepared and circulated among its members a separate report giving additional details and information on the needs of countries.

(a) Flood

17. Most of the respondents to the survey indicated that their main need for special information concerned assessment of the extent of flooded areas and the status of infrastructure, including dwellings, primarily in the crisis phase. They indicated that to assess the status of infrastructure, they would require a ground resolution of less than 10 metres and, to assess the extent of the flooded area, 20-30 metres. The information was optimally required within one to six hours after the occurrence of the disaster, with a repeat interval varying from several hours to a few days. Responsibility lay first with the local rescue and emergency relief authorities or decision makers. The working environment during a flood was considered to be a field office. The equipment required ranged from small boats to helicopters.

(b) Forest fires

18. In the case of forest fires, the majority of the respondents indicated that the priority spatial information needs were associated with the assessment of the extent of the affected area, estimates of fire evolution and damage estimates. The priority needs were identified primarily for the crisis and recovery phases. The critical spatial resolution needs ranged from 10 metres or less for infrastructure and buildings, to 100-300 metres for the burnt or forested area. Concerning the time required for the delivery of information in the crisis stage, some of the users indicated the need for immediate delivery, while some others indicated times of up to 16 hours. To monitor fires, the revisit interval could be as short as 15 minutes in situations of rapid shifts in wind direction. According to a recommendation of the working group on forest fires, which had been established by the Action Team, the affected areas might need to be monitored every few hours and up to every 12 hours. The responsibility for dealing with the disaster was considered to reside primarily with the local decision makers. There was a consensus among the respondents that a field office was the typical working environment for this type of disaster.

(c) Droughts

19. For droughts, the most relevant issues related to land use and land cover mapping and to the warning phase. The detection of drought conditions could be made on the scale of 30 metres in the case of farmland and up to 500 metres for a land cover map. The onset of the disaster needed to be reported within a couple of weeks. The interval for updating of information would vary from several days to a

few months during the crisis and recovery phases and from several months to a year for planning and warning purposes. Planners were considered to be responsible for taking action, along with local relief workers. In all phases of the disaster, a field office was regarded as the typical working environment.

(d) Earthquakes

20. With regard to earthquakes, the user views were split between those who placed emphasis on the planning and warning and others who saw the situation purely from the standpoint of post-disaster damage assessment, or the crisis phase. The priority spatial information need for planning was basically associated with the assessment of land use and the extent of urbanization, as well as hazard and structural mapping on a yearly basis by means of 30 to 100 metre resolution data. In the crisis phase, for damage assessment, it was considered desirable for 1-3 metre resolution data to be available within one to three hours and for data to be provided every two to three days. The responsibility for action lay with decision makers, rescue workers and the insurance sector at the local level.

(e) Oil spills

21. Insofar as oil spill disasters were concerned, the most important spatial information by far was felt to relate to the location and the extent of the oil slick and its displacement rate. The resolution required for vessel detection needed to be better than 10 metres, whereas for oil-slick tracking, the resolution should be 20 metres.

(f) Ice hazard

22. The warning phase, involving mitigation and preparedness, was examined for all the various aspects of ice hazard disaster, which included detection and characterization of sea and lake ice, tracking of vessels trapped in sea and lake ice, iceberg detection and breaking up of land-fast, lake and river ice. The spatial resolution required was 100 metres for detection and 50 metres for characterization of sea and lake ice, 30 metres for tracking of vessels, 10 metres for iceberg detection and 30 metres for ice break up. In terms of the coverage requirement, the survey indicated a need for daily coverage for detection and characterization of sea and lake ice and iceberg detection and twice a day for trapped vessels and land-fast, lake and river ice break-up. The delivery time in all cases needed to be less than three hours.

2. National capacity

23. The first question addressed in the survey was whether there existed in the country a designated government authority that was mandated or entitled to request, receive and use space-based information for disaster management. Only a few countries were able clearly to identify a single government authority. In some cases, the authority was distributed according to the area of work, such as hydrology, mapping and surveys. In other cases, the authority was spread among regions.

24. The survey results indicated that one of the main obstacles to the use of space-derived information was the delay in information dissemination. Individuals dealing with the disaster crisis needed to have faster transmission devices to receive the

information in near real time, so that the information would have some value for them. National capacities were very limited in that area.

25. The results of the survey indicated that the maintenance of archives of satellite images was very inadequate. Imagery pre-dating a disaster is crucial to allow comparison with the imagery acquired during and after the disaster, in order to carry out damage assessment and identify differences. The survey revealed that most countries did not have data processing and fusion facilities. The absence of geographic information systems in many cases was also noteworthy.

26. In terms of topographic coverage, 80 per cent of the territory covered in the survey was found to be covered by maps at a scale of 1:50,000 and more than 50 per cent at a scale of 1:25,000. In view of the limited samples used in the survey, however, those figures need to be considered with caution before applying them to the global landmass. Many countries were found to have inadequate mapping at such large scales and maps with a 1:250,000 scale were more common, although the frequency of revision of the map was not always optimal even at those scales. Land cover and land use maps with a low spatial resolution would need to be updated every five years, at least in urban and cultivated areas; however, based on the survey, there does not seem to be any systematic estimate for topographic updates. Terrain elevation models are of crucial importance in the event of certain disasters, such as floods. These can be of lower resolution (10 to 20 metres) but need to be much more accurate for flood plains. According to the survey, no more than a few countries have accurate digital terrain models available to their hydrology departments.

27. The need for a comprehensive international training programme, both at the level of experts and the level of field officers, was widely recognized. Such a training programme should be made available once the space systems have been clearly defined and once the mechanisms for their operation to provide disaster support have been established. The survey results showed that the number of people to be trained would be in the order of 500 at the expert level and no less than 5,000 at the field officer level.

28. Based on their national capacity and their needs, countries can be grouped into the following three categories:

(a) More developed countries that are increasingly concerned with addressing environmental security. They are investing a significant amount of resources in developing capacity to meet monitoring and preparedness needs;

(b) Countries that may have some capacity but which are making comparatively slow progress towards integrating space technologies into disaster management, primarily because of insufficient funding;

(c) Most developing countries, which are affected most by disasters, where the concept of the use of space technology has yet to play a significant role in disaster management and mitigation.

3. Space systems

29. The Action Team prepared a document containing a detailed inventory of space systems. The information compiled in the document assisted the Action Team in evaluating the effectiveness of space technologies to meet the needs of users and the ability of their respective countries to integrate space technologies into their

disaster management structures. In addition to describing the programmes, initiatives and space systems and sensors of choice for disaster management, the present report examines the types of products offered by the space data providers and the policies that govern the use of and access to those products.

30. The potential benefits of space information in disaster management can be grouped into two primary phases:

(a) A "hot phase", dealing with the emergency response. This constitutes the following actions:

(i) *Warning*. Obtaining and transmitting early and accurate warning information to the end users (for example, civil protection authorities) in a timely and credible way during, for example, a tropical storm, a flood, a volcanic eruption or an oil spill. The quality and timeliness of the information is a key factor in saving lives and protecting property;

(ii) *Crisis management*. Identification and mapping of the damage, forecasting the crisis evolution and further damage and providing support to relief staff and local authorities. This support can be provided in the form of facilitating site access and providing communication networks;

(b) A "cold phase", or the period preceding or following the crisis period. The following actions are expected in this phase:

(i) *Risk reduction*. Risk reduction focuses, as much as possible, on the magnitude of the crisis in terms of the extent to which the impact of an eventual crisis can be reduced, for example by constructing dams and dykes and managing forest and land cover. Crisis reduction also means controlling vulnerability, that is, reduction of exposure to risk through, for instance, improved land-use practices and urban policies and shockproof construction standards. This would require better risk maps than presently available in order to provide more accurate information to citizens on the location of potentially hazardous zones, restrictions on land use in the hazard zone and means of protection;

(ii) *Damage assessment*. Major disasters cause considerable damage over large areas. Evaluating the damage, preparing for the rehabilitation work and assessing the destructive impact of disasters in the region affected are of paramount importance.

31. Risk reduction is the most important goal. Nevertheless, it is clear that the international community is continuously struck and challenged by "hot" situations of distress caused by floods, earthquakes, forest fires and storms and the need to provide adequate response to such situations on an emergency basis.

32. Space systems are a unique tool in managing the "hot phase" of disasters. They provide fast and frequent information on a given site, regardless of the severity of destruction of the local infrastructure, and they can provide synoptic views and restore communication capabilities.

33. The sensors that can be used for disaster monitoring from space are both passive and active in nature and cover a wide part of the electromagnetic spectrum. They include optical high-resolution imaging devices, multi-spectral radiometers and active microwave sensors. Some of the satellite sensors are better suited than

others to cover particular types of disasters. For example, infrared sensors are adapted to detect forest fires, whereas microwave devices are preferable for monitoring sea ice and oil spills. There has been a growing trend towards obtaining multi-satellite data and extracting information using data fusions.

34. The character of the space programmes and initiatives varies. Ad hoc study groups or linkages among programmes and initiatives have been established. Some programmes have been established as operational initiatives of data acquisition and data use for short-term disaster response and for long-term term planning to address environmental and security needs.

35. International satellite data collection and data product distribution are largely in the hands of private sector entities and subject to data policies of national space agencies. Data policies vary depending on the category of data use, with minimum cost to the data user in the case of public good and research, and partially commercial, partially non-commercial government pricing schemes. In specific cases, data distribution is under the direct control of government departments. The application of data policy also varies depending on the type of data, whether it has already been collected and archived or whether it requires a new acquisition by satellite. Data delivery on an urgent basis, as is the case for disaster crisis response, may have different data delivery implications.

B. Main findings

36. Based on the information collected in the survey phase, working groups were established by the Canadian, Chinese and French co-chairs to study possible features of an integrated global disaster management system from various aspects. These working groups focused on identifying the key technical, operational, organizational, financial and educational issues and their implications for each type of disaster. The present section summarizes the findings of the working groups.

1. Practical issues for specific types of disaster

(a) Floods

37. For flood-related disasters, the available resolutions from space are appropriate to map the flooded area. However, small objects, such as buildings and bridges, are hard to distinguish without high-resolution imagery mainly from commercial suppliers. The limited useful electromagnetic range of optical data may make image interpretation difficult, particularly in the case of flooding of densely populated areas. The frequency of coverage by a single satellite is not adequate, but can be improved by combining data from different satellites. The value of space-based data can be increased for the decision makers by combining space-based data with ground data. The most important piece of information needed immediately following a flood is a wide-area map, with the addition of a few physical or administrative references, such as roads or political boundaries, to give an appreciation of the extent of the flood by comparison with map or imagery from before the flood. A second set of products is needed to monitor the evolution of the flood and to plan recovery by merging the image maps with geo-spatial data. This is done through the use of land-use maps, digital elevation models, geological maps and demographic data in a geographic information system. Data transfer using the

Internet alone is not the most reliable means and must be combined with the use of space-based communication satellites. A system of local archiving may ensure quick access to any available image and data that are needed soon after the disaster or later for the recovery phase. Floods are treated as crises despite their recurrence. More attention needs to be paid to the prevention phase. Data costs are prohibitive and funds are not always available. The current data policies do not help situations of emergency in developing countries.

(b) Forest fires

38. The technical parameters for forest fires are good but not optimal. More spectral bands are needed on platforms. The temporal frequency is not the most adequate. Though the coverage frequency is good, the spatial resolution is not always appropriate and the geographic coverage is limited. The satellite data products that are compatible with ground-based products and services are generally not available in an appropriate format for those dealing with the hazard. From an operational viewpoint, data policies and communication capabilities are limiting factors and funding from national budgets for data and equipment is unpredictable. Data pricing schemes are typically not designed for operational fire-hazard monitoring. Access to space facilities is improving, but the cost of data remains an impediment. Data ordering, handling and delivery is improving with online capabilities. Data turnaround is, however, not sufficient owing to limited funding and resources. National and international partnerships need to take into account the sharing of data with end users. A wealth of information could be integrated with satellite-derived products, but data formats and other databases are often not compatible. There are only a few specialized institutions dedicated to developing and providing products, technology transfer and education to deal with forest fires.

(c) Drought

39. Drought is an evolving disaster and, as such, does not have an emergency response phase as do other disasters. It affects mainly agricultural crops, forest, grasslands and the ecological environment. Drought does not have special requirements for spatial and temporal resolution, although spectral resolution becomes important at various stages of soil and land cover dryness, as well as humidity levels of soil and vegetation. Spectral resolution should therefore be enhanced. Further research on the spectral characteristics of various types of crops and forest is needed for optimal band selection. Drought prediction models also need to be refined.

(d) Earthquakes

40. In the case of earthquakes, the existing technical capability of space instruments is sufficient during the early stages. However, the coverage frequency should be increased and there should be more integration between space and ground data and services. If the countries affected by earthquakes wish to benefit from space-based data, rescue personnel must be trained in the use of both space and ground data. Earthquake management is still in the stage of research and development. Very-high-resolution synthetic aperture radar missions and the related interferometric techniques need to be developed specifically for the management of earthquakes.

(e) Oil spills

41. A single sensor is not always capable of detecting an oil spill in a reliable manner. Data from various types of space-borne sensors (synthetic aperture radar, panchromatic, multispectral and hyper-spectral imagers) are needed to be combined with ground data (airborne and meteorological) and geographic information systems, including bathymetry. The end product should include an estimate of the thickness of the oil spill. More research and development is required to refine models of movement of oil spills. Daily coverage is necessary for monitoring an oil spill and even shorter revisit frequency is necessary for early warning. In order to reduce the total response time, a constellation of satellites is desirable. The image processing time creates a bottleneck. The data receiving and processing systems should be automated and prioritized. Insofar as technological disasters other than oil spills are concerned, not enough information on technical requirements is available. The issues related to the monitoring of radioactivity need to be addressed. Data costs are too high to manage this type of disaster in developing countries. The availability of free data may help developing countries to deal better with this type of disaster. A fund for supporting use of space data in oil spill disasters could be established by oil companies, oil transporting companies and Governments of major oil importing and exporting countries. Training of operational staff is important. For that purpose, standard training material could be prepared and past experience among countries could be shared.

(f) Ice hazard

42. The main purpose of managing ice hazard is to allow ships transiting icy waters to navigate safely and to support maritime rescue operations. High-resolution products derived from several satellites are being used to manage ice hazard. Standard visible and infrared satellite sensors are, however, not appropriate. Synthetic aperture radar sensors are considered to be the best alternative for high-resolution products for ice hazard. Iceberg detection requires aircraft reconnaissance in addition to satellite surveillance. The coverage frequency is adequate for daily monitoring, but satellite tasking is a problem for routine use. The geographic coverage is global and varies with sensor type and latitude. The narrow swaths of synthetic aperture radar sensors leave gaps even at high latitudes. The data product compatibility is judged to be adequate, although it requires significant expertise to interpret the data. The data delivery mechanisms on the ground are inadequate for short-turnaround needs. Near-real-time is the standard data delivery requirement. The commercialization of synthetic aperture radar systems and current data policies are creating barriers to the full utilization of space data for ice hazard management. The existing agreement between the United States and Canada on use of data from RADARSAT-1 by their respective national ice centres presently provides a good model of cooperation, but the effects of shortage of funds for future cooperative arrangements need to be closely monitored. The level of training in synthetic aperture radar analysis and ice information extraction tools is limited and should be augmented. Research and development will be crucial as the next generation of satellites becomes operational.

2. Implications for an integrated system

43. Technically and operationally, the whole spectrum of Earth observation satellites, from geostationary to polar Earth orbiting higher resolution satellites, can be used for obtaining data on any given disaster during its various phases and for delivering those data to the user. The Earth observation industry and government and academic institutions should guide the potential users on existing technological developments, so as to estimate requirements, prepare budgets and develop information-gathering capacity and dissemination pathways. Despite the existence of a large number of ground data-receiving stations, the provision of station coverage is highly fragmented and, as a result, data turnaround is adversely affected. The ground receiving station coverage should be worldwide. There are not many countries with ground stations that are able to receive and process high-resolution satellite data. A coordinated response to a disaster by means of a single point of access to global space assets is required. An important achievement of the proposed global disaster management system would be to reduce the turnaround time to within 24 hours, in order to match the dynamics of the operational management of a crisis.

44. From an organizational viewpoint, it is important to share and document research and development and operational results at a global level, as well as local capacity-building efforts. This can be achieved by assigning a designated governmental authority that would be responsible for disaster relief and mitigation and that would interface with the space data and services providers. These national authorities should themselves be equipped with the front-end architecture, such as cartographic, hydrological, meteorological and demographic databases, that is critical for an effective use of Earth observation in the disaster management cycle. The promotion of the use of Earth observation satellite data can be achieved by interaction with space operators on a regular basis through conferences, forums and workshops and by setting up comprehensive international training programmes.

45. The main financial issue concerns data-pricing policies of space data providers and the funding for defraying data costs, operating a global system and developing data products and services, including value-added products and services. The space data providers have developed policies for making the data available from their respective space resources. No attempt has been made so far to establish a single international Earth observation data policy. However, the data-pricing policies of individual data providers are not always based on commercial reasons. The questions that need to be addressed concern affordability and the distribution mechanism. Nearly every country has appointed an authority for disaster relief at either the national or the regional level or distributed over both levels, with some allocation of financial resources. The creation of a global system would require global funding opportunities; this is particularly true for developing countries. The attention therefore needs to be focused on international funding institutions and stakeholder contributions. Included among these are the World Bank and its affiliates, regional organizations and lending institutions, international humanitarian aid agencies, national developmental assistance programmes, the insurance sector, non-governmental organizations and internationally supported geo-information units. The Action Team on Innovative Sources of Funding established by the Committee on the Peaceful Uses of Outer Space has examined this issue.

3. Required characteristics of an integrated system

46. The present report has discussed above the real and potential benefits of harnessing space information to support disaster management. However, what is required is the development and establishment of a focused, perhaps dedicated, disaster management satellite support system.

47. The benefit derived from the utilization of space assets today is neither yet fully understood nor exploited. This is owing to the insufficient level of organization of a global space observing system as it now stands. The players in this system would include the space data providers (public or private), the value-added enterprises that have the expertise to process pertinent information from the raw data and the national and international authorities that make use of the information for operational decision-making with regard to disaster management.

48. The Action Team finds that there must be a better match in timeliness, preparedness, information content and affordability among the components of the global system in order to realize the concept of a disaster management satellite support system. This requires a step forward by the entire space community, with the support of the international authorities involved in disaster management, to provide assistance for better integration and performance of the system and to facilitate the roles and contributions of the various players so as to increase the benefits derived from space for disaster management authorities and ultimately for the populations affected by disasters.

49. The concept of a global integrated disaster management system that employs space-based resources should take into account the following:

(a) The existing space systems are operational, semi-operational or experimental depending on the degree of satisfaction in terms of the needs of users for disaster crisis, recovery, mitigation and preparedness. There is currently too much emphasis on crisis response and not enough on prediction and prevention. The use of space data should not stop at emergency relief, but should target planning and prevention. For example, an early warning system for floods, droughts and landslides could be established on a regional basis. Similarly, a better use of meteorological satellites could be made for disaster preparedness. This would result in reduction of the risks and management of the vulnerabilities of local communities by national decision makers;

(b) A more beneficial relationship between technology providers and technology users should be pursued through educational and promotional programmes for the users to handle data and to have the right expectation of the products to be delivered. In the end, users are not interested in the source, but in the type of information that they need in support of disaster management. Simply facilitating access to data holdings will not necessarily maximize data use in disaster management. A more flexible means of establishing information-service pathways will have to be evolved to meet the various needs of the users if the acquisition of Earth observation data is to be advanced and sustained. Furthermore, a more beneficial relationship between technology providers and technology users should be established by paying attention to long-lead development of sensors for specific purposes, satellites that carry the sensors and the objectives of the missions for which the sensors and satellites are designed. This would maximize a return on investment for both providers and users and future needs of the disaster management applications;

(c) Space technologies alone are not enough in managing disasters, but can be effective when used in conjunction with other tools and processes, such as airborne and ground-based remote sensing and conventional techniques, modelling and emergency communications systems. Background cartographic databases are often essential for interpretation and manipulation of space data. The existing hydrological and geophysical models could be improved with space data input;

(d) The new constellation of satellites and sensors are expected to enhance the temporal, spatial and spectral coverage of disaster sites. High-resolution space imagers and timeliness of data deliveries in user-friendly format remain of critical importance to disaster management;

(e) Space-based disaster management support should be a common endeavour among all stakeholders, requiring the participation of technology suppliers and operators, data users, insurance and communications industries and government sponsorship to share the costs of the system;

(f) A large number of countries have little or no exposure to space technologies and their applications. Therefore, local capacity-building is important for space applications for disaster management and to enable the organizations concerned to develop products and services in order to achieve a dynamic equilibrium among user needs, national capacity and space systems;

(g) Disaster management in most countries is spread over several responsibility centres, which is not helpful for the integration of space technology. A single contact point should be designated to interface with space data providers and should be part of the global space-supported disaster management system. An international centre, virtual or physical, for disaster management connected to local and regional structures is one way of implementing the system. One of the main roles of such an international entity would be that of a study centre, which could provide quick and effective consultancy and decision-making alternatives for its customers and associates. The centre could be placed under the umbrella of the United Nations, or endorsed by it, to ensure sustainability and visibility;

(h) There are some notable international efforts, such as the International Charter on Space and Major Disasters, the constellation of Disaster Management Centres, the Global Monitoring for Environment and Security initiative of the European Union, the geohazard theme under the Integrated Global Observing Strategy and the Earth Observation Summit held in Washington, D.C. in July 2003, the outcome of which is being implemented through a Group on Earth Observations. All these efforts are aimed at addressing the need to develop more coordinated use of space assets and make the global system more suitable for disaster management and other applications. The International Charter has provided a useful impetus to the use of satellite data for disaster response, but there is a need to expand this capability by means of some similar initiatives to other phases of disaster management. These initiatives should be strengthened, for example by providing easy and secure online access to data archives, by offering speedy data processing and delivery and by supporting the cost of operating the initiatives;

(i) Public-private partnerships could be used to raise funds to implement a global disaster management system. The involvement of the insurance industry, for instance, could assist in raising appreciation of the seriousness of disaster management issues and of the need for investment in better coordinated space capabilities.

IV. Recommendations

50. On the basis of the results of its analysis, as reflected in the previous chapters, the Action Team reached the following conclusions:

(a) Disasters such as floods, earthquakes, fires, oil spills, droughts and volcanic eruptions indiscriminately affect all parts of the globe. Thus, coordinated international efforts are required to minimize their impact;

(b) Disasters require timely and up-to-date situational analyses through the full cycle of disaster management, namely, mitigation, preparedness, response and recovery linked to geo-social databases or thematic maps;

(c) Space technology, such as Earth observation, communications and navigation and positioning, can provide the necessary information for disaster management and the means to transmit that information to decision makers in a timely manner. Considerable investment has been made globally in these areas;

(d) However, the applicability and utilization of these assets in support of disaster management continue to lag significantly behind development activity and remain a major challenge in almost all parts of the world, despite the notable international efforts described above. In fact, a considerable gap exists, and is likely to remain, in all areas of space technology application (technical, operational, educational and training, organizational and financial) to disaster management on a global basis unless a more integrated, coordinated approach is taken. This is because of the diversity and enormity of the challenge and the lack of sustained, focused and coordinated efforts to meet the needs of the disaster management community;

(e) In virtually all countries, the responsibility for managing disasters is diversified and not well understood, at least insofar as the contribution that space technologies can make in that regard.

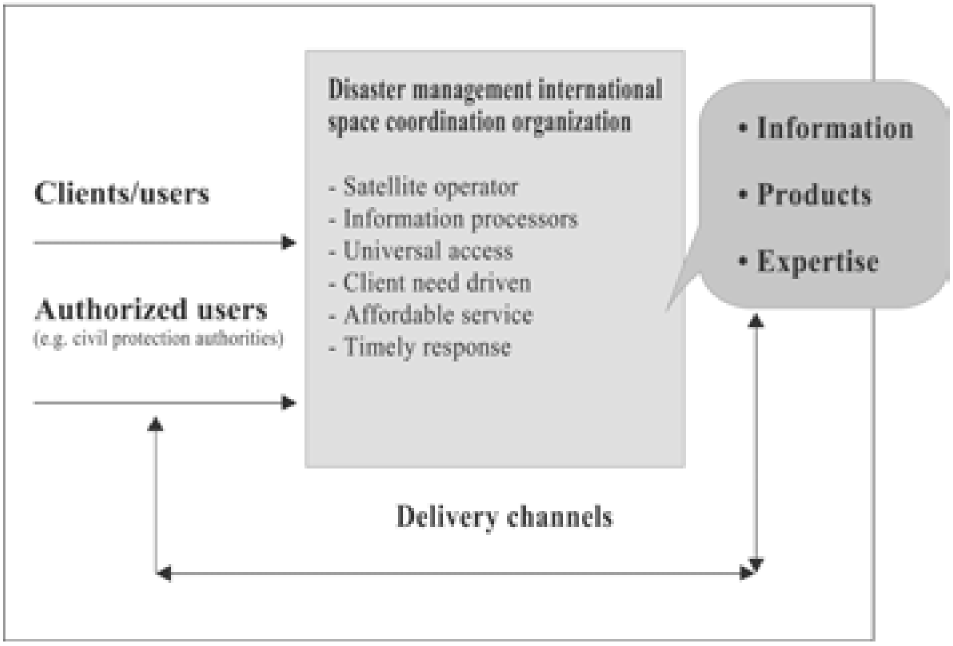
51. Consequently, the Action Team has made the three key recommendations below.

Recommendation 1

52. An international space coordination body for disaster management, nominally identified as the "disaster management international space coordination organization", should be established. Such a body would have the mandate to provide the necessary means to optimize the efficiency of services for disaster management. The concept would be based on a disaster management space support system for all stakeholders (both authorities and other clients): users of various backgrounds (civil protection agencies, lending institutions, emergency response units and national capabilities); the value-added centres and companies; and finally, the space data providers in the public and private sectors. The system would cover

all phases of disaster management, including prevention, mitigation, preparedness, response and recovery, and would provide affordable, comprehensive and universal space-based service delivery by fully utilizing existing and planned space- and ground-based assets and infrastructures, with the full participation of organizations and mechanisms currently in place. The concept of the functioning of such an organization is elaborated in the chart shown in the figure below.

Figure
Concept for a proposed integrated global disaster management system



53. Based on the analysis of requirements detailed in the previous chapters of the present report concerning the full utilization of space technology for disaster mitigation and management on a global scale, particularly in developing countries, the following key functions are foreseen for the disaster management international space coordination organization:

(a) Coordinating policy (data pricing and access);

(b) Standardizing product and service delivery;

(c) Collecting, updating, analysing and distributing knowledge;

(d) Providing project management and technical support for capacity-building on request;

(e) Arranging education and training services.

54. The proposed organization would act as the focal point for global space efforts in support of disaster management and would help to achieve an integrated global space system that is operational and effective in meeting the needs of civil protection agencies and other users in all phases of a disaster.

55. The proposed organization, possibly operating with the endorsement of the United Nations, would rely on existing and planned assets and infrastructures and on existing organizations, programmes and initiatives to achieve the integrated global disaster management satellite support system. It would provide affordable, universal and efficient space-based service delivery in support of disaster management.

56. The Action Team recommends a pragmatic approach, building on the experience of existing operational initiatives, such as the International Charter on Space and Major Disasters, in the response phase and expanding the role of the proposed organization to the full cycle of disaster management.

57. This organization would support the efforts of the Committee on Earth Observation Satellites, the Integrated Global Observing Strategy, the Global Monitoring for Environment and Security initiative and the Group on Earth Observations in developing space infrastructure more suited to the needs of the disaster management community and filling information and observational gaps. It would also rely on the education and training efforts of the United Nations Economic and Social Commission for Asia and the Pacific, the United Nations Educational, Scientific and Cultural Organization, the Office for Outer Space Affairs and others to obtain the critical knowledge of space technology for users in the field of disaster management.

58. The following action plan is therefore proposed to implement recommendation 1:

(a) Secure critical support for the start-up of the proposed organization;

(b) Set up a small coordination office composed of seconded personnel from member States;

(c) Define key functions of the proposed organization (administration, data policy coordination, product standardization, capacity-building for developing countries, provision of education and training for end users and stakeholders, analysis and promotion of space benefits);

(d) Establish a site for centralized access to Earth observation data archives;

(e) Establish a sample product catalogue;

(f) Develop a case history of benefits;

(g) Within six months, develop an implementation plan to define:

(i) Management organizational structure;

(ii) Functionality requirements;

(iii) Resource requirements;

(h) Secure approval of the implementation plan;

(i) Achieve the goal to have a fully functioning organization within three to five years.

Recommendation 2

59. A fund should be established to provide sustainable resources to support the effort. The fund should be used to apply space technology in support of disaster management and to build capacity of national and international civil protection and rescue authorities to use space technology.

60. The primary contributors to the fund should be development and relief organizations and those who would be the main beneficiaries of disaster reduction, such as insurance companies, lending institutions, resource companies and end users.

61. The following action plan is proposed to implement recommendation 2:

(a) Secure critical support to study the concept behind the fund;

(b) Set up a working group to establish needs, develop options, propose preferred solutions and recommend an implementation plan;

(c) Achieve the goal to set up preliminary funds one year after approval and full funds in three years.

Recommendation 3

62. Member States should be strongly encouraged to allocate a portion of their disaster management resources/funds to using space technologies and to identify single points of contact for their respective countries, in order to focus their internal disaster management activities and to liaise with external efforts.

63. The following action plan is proposed to implement recommendation 3:

(a) Raise awareness of issues and needs through participation, presentations and media relations;

(b) Promote benefits (namely, education efforts, pilot projects for developing countries and proof of concept for space-based response).

V. Conclusions

64. The work of the Action Team in recommending an integrated global disaster management system has been a methodical, sustained and highly consultative and well-documented process. It consisted of a variety of surveys, gap analyses and discussion sessions. The next important step is to gather critical support for these recommendations from Member States and their relevant agencies, appropriate international bodies and end user representatives and to enter into partnership with the existing initiatives, programmes and themes related to disaster management with space and non-space-based resources and those related to coordination of space assets more generally. For this purpose, a small coordination office could be set up to work on short- and long-term implementation of the proposed solutions for the global system and to establish linkages with the stakeholders and other players in the field. Such an office would establish the organizational structures and would develop their functionality and resource requirements.

65. In the short term, there is an equally important need to obtain funds, raise awareness and promote the benefits of implementing the proposed global system.

Notes

[1] See *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1, sect. I, para. 1 (b)(ii).

[2] International Federation of Red Cross and Red Crescent Societies, *World Disasters Report 2003: Focus on Ethics in Aid*, Jonathan Walter, ed. (Bloomfield, Connecticut, United States of America, Kumarian Press, 2003), p. 239.

Annex

Terms of reference of the Action Team on Disaster Management

Mandate

The Space Millennium: Vienna Declaration on Space and Human Development[a]

> "To implement an integrated, global system, especially through international cooperation, to manage natural disaster mitigation, relief and prevention efforts, especially of an international nature, through Earth observation, communications and other space-based services, making maximum use of existing capabilities and filling gaps in worldwide satellite coverage."

Co-chairs

Canada, China and France

Purpose

To study the implementation of an integrated, space-based, global natural disaster management system.

Related activities

Conduct related studies and propose a plan for a global disaster mitigation and management system or systems that would fully utilize existing space and ground resources, including those of the United Nations system.

Participants

States Members of the United Nations

Argentina, Australia, Azerbaijan, Belarus, Bolivia, Canada, Chile, China, Colombia, Cuba, Czech Republic, Ecuador, Egypt, Finland, France, Germany, Greece, Hungary, India, Indonesia, Iran (Islamic Republic of), Italy, Japan, Kazakhstan, Lebanon, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Portugal, Russian Federation, Saudi Arabia, Senegal, Syrian Arab Republic, Thailand, Turkey, United Kingdom of Great Britain and Northern Ireland and United States of America.

United Nations Secretariat

Economic and Social Commission for Asia and the Pacific, Office for the Coordination of Humanitarian Affairs, Office of the United Nations High Commissioner for Refugees, secretariat of the International Strategy for Disaster Reduction, United Nations Environment Programme and United Nations Office for Project Services.

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[a] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1, sect. I, para. 1 (b) (ii).

Specialized agencies in the United Nations system

Food and Agriculture Organization of the United Nations, United Nations Educational, Scientific and Cultural Organization and World Health Organization.

Intergovernmental organizations

European Association for the International Space Year, European Space Agency and Space Generation Advisory Council.

Non-governmental organizations

Manila Observatory and Philippine Astronomical Society.

Experts

The following experts also supported the work of the Action Team by participating in the discussion panels organized during the open session of the Action Team (10 June 2003, Vienna): I. Becking (Canada), G. Brachet (France), K. Kasturirangan (India), J. Kolar (Czech Republic), M. Jarraud (World Meteorological Organization), L. Jiren (China), R. Nussbaum (France), F. Pisano (secretariat of the International Strategy for Disaster Reduction) and F. Piso (Romania).