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REPORT OF THE UNITED NATIONS/EUROPEAN SPACE AGENCY WORKSHOP ON APPLICATIONS OF SPACE TECHNIQUES TO PREVENT AND COMBAT NATURAL DISASTERS, ORGANIZED IN COOPERATION WITH THE GOVERNMENT OF ZIMBABWE

(Harare, 22-26 May 1995)

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INTRODUCTION

A. Background and objectives

1. On 10 December 1982, the General Assembly adopted resolution 37/90 in which it endorsed the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. In that resolution, the Assembly decided, *inter alia*, that the United Nations Programme on Space Applications should disseminate, through panel meetings and seminars, information on new and advanced technology and applications, with emphasis on their relevance and implications for developing countries.

2. The United Nations/European Space Agency Workshop on Applications of Space Techniques to Prevent and Combat Natural Disasters was one of the activities of the Programme for 1995 that were endorsed by the General Assembly in its resolution 49/34 of 9 December 1994. The Workshop was organized in cooperation with the Government of Zimbabwe. It was hosted by the Environment and Remote Sensing Institute (ERSI) and held at Harare, from 22 to 26 May 1995, for participants from developing countries of the region covered by the Economic Commission for Africa (ECA).

3. The objectives of the Workshop were (a) to expose the participants, particularly managers of emergency response agencies, to ways and means of utilizing space technology (remote sensing, satellite meteorology, satellite communications, positioning by satellites) to prevent or mitigate the effects of natural disasters; and (b) to address the development of databases and their use with Geographic Information Systems (GIS) to prevent disasters or to monitor, mitigate and redress the effects of disasters when they occur.

4. The presentations to the Workshop covered the use of remote sensing, satellite meteorology, satellite positioning systems and satellite communications and how they could be used, separately or collectively, to prevent disasters or to forecast, monitor and mitigate the effects of severe weather phenomena, such as flooding, desertification and drought. The presentations also addressed the extent to which the same technologies could mitigate the effects of earthquakes and volcanic eruptions. The Workshop concluded with discussions on the needs of the emergency response services, the capabilities of space technology to satisfy those needs and the actions that would be necessary in the short- and medium-term to take advantage of those capabilities.

5. The present report, which covers the background, objectives and organization of the Workshop, the observations and recommendations made by the participants, as well as a summary of the presentations, has been prepared for the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. The participants will report to the appropriate authorities in their own countries.

B. Organization and programme of the Workshop

6. The participants were professionals with several years experience in managerial positions with national and regional emergency response agencies and services. Other participants had several years experience in remote sensing, satellite meteorology and the use of databases such as GIS. Sixty-nine experts from 18 States Members of the United Nations and eight international and regional organizations participated in the Workshop; 44 participants represented 14 developing countries from the ECA region.

7. The Workshop was attended by participants from the following countries and international organizations: Benin, Botswana, Egypt, Ethiopia, Ghana, Kenya, Malawi, Nigeria, South Africa, Sudan, United Republic of Tanzania, Zambia and Zimbabwe. Presentations were made by experts from Ghana, France, Japan, Norway, South Africa, United Republic of Tanzania, United States of America and Zimbabwe; from European Space Agency (ESA), International Federation of Red Cross and Red Crescent Societies (regional delegation for Southern Africa), International Mobile Satellite Organization (Inmarsat), International Telecommunications Satellite Organization (INTELSAT), Food and Agriculture Organization of the United Nations (FAO), Department of Humanitarian Affairs of the United Nations/International Decade for Natural Disaster Reduction (UNDHA/IDNDR), United

Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Office for Outer Space Affairs, as well as by a representative of the Globalstar satellite communications company.

8. Funds allocated by the United Nations and ESA were used to defray the air travel and per diem expenses of 14 participants from 11 developing countries of the ECA region. The Government of Zimbabwe, through ERSI, provided the conference facilities and the Government also provided local transportation for all participants in the Workshop.

9. Opening addresses were made by Prof. C. J. Chetsanga, Director-General of the Scientific and Industrial Research and Development Centre of Zimbabwe, on behalf of the Government of Zimbabwe, C. Berquist, the representative of ESA, and the Expert on Space Applications, Office for Outer Space Affairs of the United Nations.

10. The programme of the Workshop (annex I), was developed jointly by the United Nations and ESA. The Workshop held plenary and working group meetings. At the latter, the participants discussed the issues related to the use of space technologies to prevent and combat the effects of natural disasters. The working papers of these groups are given in annexes II-V.

I. OBSERVATIONS AND RECOMMENDATIONS OF THE WORKSHOP

A. Observations of the Workshop

11. The critical factors that distinguish natural phenomena from natural disasters are loss of life and property. Certainly, humans cannot prevent the occurrence of natural phenomena such as typhoons, hurricanes, earthquakes and volcanic eruptions. Their disastrous effects, however, can be lessened significantly if well-conceived disaster-response plans and mitigation strategies are in place prior to their occurrence.

12. The Workshop noted that developing countries were particularly subject to natural disasters on a scale that overwhelmed the capacity of the societies concerned to cope with their aftermath. In many cases, just one such destructive episode was sufficient to destroy the social and economic infrastructure, including the communications network. A single major disaster could disrupt the distribution of food and water supplies, medical services, and both the local and international communication links of the stricken communities.

13. The Workshop noted that many of the national and regional emergency response agencies and services were not aware of the full spectrum of applications of space technology. Of particular concern was the lack of awareness of the Earth observing systems that could provide essential data for the prevention of disasters or for the mitigation and relief of their effects. To a lesser degree, the same observations applied to satellite communications, particularly regarding recent developments in mobile communications. In the case of natural disasters, such technology could restore communications with the local headquarters for rescue and relief operations as well as with the outside world.

B. Recommendations of the Workshop

14. During the last session of the Workshop, the participants defined four categories of disaster-related topics that needed to be addressed: data supply, information generation, decision-making and implementation/execution. To develop outlines of recommendations that could be useful in disaster-related activities, the participants assigned themselves to one of the above groups according to their professional background.

II. SUMMARY OF PRESENTATIONS

15. In recent years, the frequency and magnitude of major disasters, whether of a natural, technological or ecological origin, have made the world community aware of the immense loss of human life and economic resources

that are regularly caused by such calamities. Particularly hard hit are developing countries, for which the magnitude of disasters frequently outstrips the ability of the society to cope with them. It was stated that this was due to the fact that 95 per cent of all disasters occurred in developing countries.

16. Over the past 20 years, the frequency and severity of natural disasters have increased. Over this timespan, 3 million people have been killed and 1 billion have been affected by natural disasters. Hardly a week goes by without a major disaster. Since the earthquake in Kobe, Japan, in January 1995, there have been over 20 large disasters reported in Africa, Asia and Latin America. Civil strife, such as the recent events in Rwanda, also affects people, the economy and the infrastructure in ways similar to a very large natural disaster.

17. To date, relief continues to be the main form of disaster management. Approximately 95 per cent of all resources spent on disaster-related activities are for relief and recovery operations. Nevertheless, disasters can be reduced if adequate research and proven prevention, preparedness and emergency measures are taken. The effects of disasters can only be reduced through the deployment of the very best systems and knowledge, and following well-prepared overall national and regional contingency plans.

18. A single hazardous event can destroy the social and economic infrastructure, including communications systems, that may have taken years to develop and upon whose vitality local and national economies depend. Even in normal times, particularly in developing countries, the capacities of these infrastructures are often strained to manage even the most basic social and economic development programmes, and a single disaster can severely disrupt the community lifelines that provide food distribution, water supplies, health-care services, waste disposal and communications locally and with the rest of the world.

19. In order to realize their fullest potential, developing countries need a sustained period of social and economic growth. Major impediments to sustained growth are disasters, which often result in an affected country shifting its economic policies to sustain the energy required to cope with disaster response and subsequent reconstruction. These shifts can intensify a country's financial imbalances and deplete available resources.

20. In many cases such a situation can be prevented. Frequently, the difference between saving and losing lives and property is an effective warning of an impending disaster. Timely warning of a major natural hazard can reduce its consequences: at least, people may have enough time to save their lives; at most, they have an opportunity to relocate or otherwise protect their property.

A. The role of the International Decade for Natural Disaster Reduction and the contribution of space technology

21. The International Decade for Natural Disaster Reduction (IDNDR) 1990-1999 operates within the framework of the Department of Humanitarian Affairs of the United Nations and was proclaimed by the General Assembly in its resolution 44/236 of 22 December 1989 with the objective of reducing, by concerted international action, especially in developing countries, the loss of life, property damage and social and economic disruption caused by natural disasters such as earthquakes, windstorms, tsunamis, floods, landslides, volcanic eruptions, wildfires, infestations of grasshoppers and locusts, droughts and desertification, and other calamities of natural origin.

22. The IDNDR secretariat recognizes that space technologies, including remote sensing, global positioning and satellite communications systems, offer disaster managers valuable tools that can be used to prepare for, mitigate and, in some cases, prevent the effects of disasters. Appropriate applications of space technologies can also be used to respond more effectively to needs resulting from disasters.

23. IDNDR provides an international mechanism to focus attention on the benefits of applying these and other technologies. Importantly, it directs the disaster management community beyond the issue of simply using state-of-the-art space technologies in disaster relief and early warning because it promotes a recognition that the national infrastructures that make possible these applications must be encouraged and supported.

24. Because of the typically high infrastructure investment that is required for constructing and managing space-based programmes, national, and local, systems are out of reach for most of the countries hardest hit by natural disasters. Therefore, the IDNDR secretariat is seeking ways of encouraging the development of cooperative approaches for sharing space-based resources. Although the sovereignty of the country affected by the disaster should be recognized, the planning and administration of this process must also include recipient countries. The development of an autonomous basic research capability in scientific and technical disciplines, including space-related fields, should be a main goal as advocated in ongoing activities within the United Nations, most notably through the Office for Outer Space Affairs. Such capability would promote creative thinking to adapt, modify and create new technologies that could contribute to national development and the reduction of casualties and property damage.

B. Regional disaster-related problems and projects

25. There are many disaster-reduction challenges confronting Southern Africa, the major hazards of concern being drought, epidemics, cyclones and storms, floods and armed conflict. In 1991 and 1992, more than 20 million people in this region were defined as severely drought affected. Drought in this region is also associated with other hazards, such as flash floods and epidemic diarrhoea, including cholera and dysentery. In 1995 there have been flash floods in Botswana, northern Namibia and parts of Southern Africa.

26. Unfortunately, for Southern Africa, cholera and dysentery constitute a serious threat. In 1993, more than 50,000 cases of cholera and up to 73,000 cases of shizella dysentery were recorded in five Southern African countries. In 1994, more than 171,000 cases of dysentery were reported for Malawi, Mozambique and Zimbabwe, claiming nearly 600 lives.

27. Irrespective of whether the hazard is meteorological, such as a cyclone, epidemiological, such as a cholera outbreak, or hydrological, such as a drought, Southern Africa's most disaster prone communities are those already vulnerable due to poverty, isolation, and dependence on degraded land and location in crowded informal settlements. Disaster reduction is synonymous with lowering this vulnerability, a daunting challenge facing Southern African governments during a time of fiscal restraint and economic structural adjustment.

28. In Zimbabwe, remote sensing and GIS projects started as small disjointed donor-funded projects that were designed to test the applicability of the technology in different fields of application. The earliest pilot projects were in the fields of land-use planning and vegetation monitoring. At that time, satellite data came in as computer compatible tapes in the diplomatic baggage of the technical personnel from donor countries. In 1987, ERSI was inaugurated as a service centre to spearhead advances in the use of remote sensing and GIS technology. The facility was set up as a joint project between the governments of Zimbabwe and Germany.

29. With time, it was realized that there was a need to coordinate the projects that were being developed all over the country in order to take advantage of already existing data sets, hardware and software to rationalize human and technical resources. The research council of Zimbabwe established a subcommittee on remote sensing in an attempt to coordinate remote sensing activities in the country. A working group on GIS was also established. ERSI is presently involved in capacity building, both in-house and within the existing and new-user community.

30. The limited success in the control of land degradation and desertification may be attributed to a number of factors that include lack of data relating to the spatial and temporal dimensions of the problem. High-resolution satellite remote sensing data is suitable for the collection of spatial data for broad planning and monitoring. The possibility of assessing in particular the spatial and temporal dimensions of the problem of desertification is enhanced.

31. In Ghana, the most extensive use of high resolution satellite data to map current land use and cover for the country is currently taking place within the Remote Sensing Applications Unit of the Department of Geography, University of Ghana. The project is using satellite image data to map land use at the scale of 1:250,000 as a part

of the Environmental Information Systems Development component of the Ghana Environmental Resources Management Project (GERMP). GERMP is part of the implementation of the Environmental Action Plan prepared by the Ghana Environmental Protection Agency (EPA). The other sets of data to be produced include topography, meteorology, soil suitability and land ownership. These databases are expected to be available by 1997 to be organized into an environmental database that will be developed and shared in an environmental information systems network. The Desertification Control Unit within EPA will be expected to use the maps to assess the medium-term and longer term effects of the many environmental and land-use programmes and projects currently being undertaken in all the ecological zones of the country, but particularly in the northern savannahs.

32. In the United Republic of Tanzania, recurring fire hazards, whether natural or human-made, have swept the vegetation off of various areas of the country except in the very wet rain forest. Deliberate or accidental fires have had disastrous effects on the ecology and economy of the areas concerned. In developing countries such as the United Republic of Tanzania, however, the deliberate burning of vegetation continues to aid farming and hunting of game in forested areas. The impact of fire on forest land can be detected by using remote sensing techniques and GIS. With respect to technology management, the latest GIS programs, IDRISI and TOSCA, have already been introduced in the United Republic of Tanzania through the United Nations Institute for Training and Research (UNITAR). It may be concluded that remote sensing images are a useful database source when used in conjunction with sufficient ground surveys in combating forest fires.

33. In 1992 a project was initiated in South Africa to develop a monitoring system for drought and vegetation conditions. This operation requires information at regular intervals at a national level. The advanced very high resolution radiometer (AVHRR) instrument carried by satellites of the National Oceanographic and Atmospheric Administration (NOAA) of the United States of America is the only commercial data source available to satisfy the needs and requirements of a fully operational exercise of this magnitude. Unique properties, such as daily coverage of a large area, facilitate regular inventories to be made of natural events on a national scale. Daily NOAA/AVHRR satellite images are used as a primary input source to produce monthly inventories of the whole country in the form of vegetation index maps. Analyses and comparisons of current and historical maps enable the objective assessment of the effect of prevailing or emerging drought conditions in a timely fashion. With proper calibration and the establishment of a continuous long-term database, this information will become a strong tool for decision makers and land managers.

C. Current and future possibilities for satellite communications

34. Traditional terrestrial telecommunications, particularly in remote areas of disaster-prone countries, have been costly to install, difficult to repair and vulnerable to damage. Accordingly, such systems have been virtually useless in areas where geography or climate have inhibited their installation and maintenance, and thus have been of limited value to disaster managers. Fixed satellite services, though useful in disaster planning and warning, have been of relatively limited effectiveness in disaster response, principally because of the need for large receiving and transmitting antennas and their associated high power requirement, and vulnerability to effects of disasters.

35. Mobile satellite services have been one of the most recent and dynamic communications technologies available to disaster managers. This low-cost communication capability has proven, even in the relatively short time of its commercial availability, to offer dramatic results in relief efforts that have not been possible before. Furthermore, as a complement to remote sensing and the global positioning system (GPS), space technology and GIS information management applications, mobile satellite services have the capability to dramatically improve risk assessment, disaster preparedness, early warning, and onset and post-disaster relief operations. These services are now available to areas previously considered inaccessible because of their location, terrain, weather or demography.

36. In the future, global mobile communications systems, such as the many planned low Earth orbit (LEO) systems, will greatly enhance the disaster mitigation efforts of relief organizations. Providing truly global personal communications, these systems, including the proposed Globalstar system, will provide a wide array of opportunities for information exchange through voice, digital data transfer and paging. An alternate, or back-up capability, will

also be provided to ground-based emergency alerting and local services for immediate reporting and request for assistance capabilities in natural disasters, accidents and other emergencies as well as aviation and marine navigation.

37. A few years ago the mobile satellite technologies that had for so long been employed on an experimental basis were only then beginning to be used in institutions. Mobile satellite services offering land, aeronautical and maritime mobile communications are now being used regularly in disaster applications and will be used increasingly throughout the 1990s and beyond.

38. The growing awareness and consideration of these societal issues together with advances in spaceborne technology mean that effective, affordable and global mobile satellite communications and remote sensing capabilities that should significantly reduce the devastating effects of natural disasters should soon be implemented.

39. Because mobile satellite communications systems are independent of the local telecommunications infrastructure, they are not affected by natural disasters and they are frequently the only means of communications to and from a stricken area. The Inmarsat satellite system can be used in all phases of dealing with natural disasters, monitoring and prediction, warning, and early intervention and emergency operations, and can also provide communications support for rehabilitation and reconstruction after a disaster strikes.

40. The 1994 IDNDR World Conference on Natural Disaster Reduction, held at Yokohama, Japan, identified telecommunications and information systems as two of the main elements of its "Strategy for a safer world and plan of action", which was subsequently endorsed by the General Assembly in its resolution 49/22 B of 20 December 1994. The Tampere Conference in 1991, as well as the World Conference on Telecommunications Development of the International Telecommunication Union (ITU), held at Buenos Aires in 1994 and the subsequent Kyoto Plenipotentiary Conference, endorsed the principle of maximum use of existing satellite and terrestrial telecommunications systems for disaster mitigation. This includes the preparation of national disaster emergency and contingency plans, establishment of pools of expertise and equipment for such purposes, inclusion of emergency telecommunications systems in national development plans and revision of national regulatory policies to allow effective deployment of telecommunications in disasters and emergencies.

41. National contingency plans can help to minimize the impact of sudden natural disasters, for example by the pre-positioning of emergency supplies and communications equipment, including satellite communications systems, at strategic locations such as government premises and hospitals in areas known to be at risk. As the process of identifying needs and the subsequent funding and deployment of satellite communications systems can take months, such activity has to be started as soon as possible.

42. For slowly developing disasters, such as droughts or famines, a different telecommunications strategy is needed. The impact of disasters on sustainable development has been shown to be very severe. As telecommunications are one of the essential tools for disaster management, the national emergency or disaster management planners need to consider how best to use the available networks and systems during the research and monitoring phase, as well as for contact with established international aid agencies during the relief phase.

43. Preparedness planning for all disasters and emergencies involves national civil defence, emergency response organizations and various government departments. The military is increasingly called on to contribute in this role. The International Committee of the Red Cross and other health organizations also participate. An increasing number of preparations are being conducted on a regional basis. While the levels of technical ability and understanding of technology of local personnel are steadily increasing, the main problem is lack of funds. This, however, can often be overcome by international cooperation or external funding.

44. Monitoring weather and climate has long been an invaluable tool in predicting and combating natural disasters. Inmarsat satellite communications systems help in the gathering and dissemination of meteorological data. The World Meteorological Organization (WMO), for example, has been using the Inmarsat-C data messaging service to send observation data from ships at sea via Inmarsat Land Earth Stations in Southbury and Goonhilly in the

United Kingdom of Great Britain and Northern Ireland. This global network of observatories using Inmarsat systems contributes to the prediction and monitoring of cyclones, hurricanes and typhoons and other variables affecting maritime weather.

45. Under the auspices of its Regional Centre for Training and Applications in Agrometeorology and Operational Hydrology (AGRHYMET) programme, WMO has recently established a network of land-based monitoring stations in western Africa. A regional centre is located in Niger. Observation posts in nine countries, each of them equipped with an Inmarsat-A portable satellite communication system, report regularly on climate and soil conditions in real-time, complementing GIS and remote sensing data. Such information enables better medium- and long-range planning of agriculture and forestry activities, and helps more effective mitigation in an area covering millions of square kilometres. UNEP is another Inmarsat user in Africa.

46. Inmarsat terminals coupled with appropriate sensors provide supervisory control and data acquisition. Such equipment can play a vital role in providing or improving the monitoring and early warning functions, even from the most remote areas. The monitoring of geothermal and volcanic variables, tectonic-plate movement and pressure ridges helps to identify potential volcanic or earthquake activity.

47. The United Nations has also recognized the utility of Inmarsat portable satellite communications systems. Its United Nations Disaster Assessment and Coordination (UNDAC) teams, dispatched to a disaster site within hours, routinely carry messaging or phone/fax satcoms when assessing disasters. Their timely reports help to mobilize experts, supplies and equipment during the crucial 24-72 hours after disaster strikes.

48. The media also uses Inmarsat systems to report on disasters, especially for the transmission of compressed and slow-scan videos, still pictures and direct, high-quality audio broadcasts. The media play a big part in highlighting a country's plight, which can help to expedite external assistance. However, it is not only the media who need accurate and timely information. During the acute phase of an emergency, speedy and accurate transmission of all relevant information is a major requirement for effective work by disaster relief organizations. Lists and reports can be compiled quickly and transmitted via mobile satellite communications systems to disaster relief coordinators and other agencies using existing software programs for the management of personnel and supplies.

49. Immediately following a disaster, field workers in their vehicles or trucks carrying relief supplies often become immobilized due to local conditions. Therefore, regular communications and position reporting is highly desirable. Using Inmarsat mobile satellite communications systems and GPS, operations control is able to monitor the progress and location of all equipped vehicles, as well as send messages to them, regardless of the state of the local infrastructure, weather conditions and other impediments.

50. The introduction by INTELSAT of the new demand assignment multiple access (DAMA) service, especially for thin-route communications, will enhance connectivity in devastated areas. It will make digital satellite public switched services available to more users, especially in rural and remote areas. DAMA is a flexible, pay-as-you-use service, offering improved connectivity at a low cost, while providing a complete digital solution for thin-route operators.

51. INTELSAT plans to introduce thin-route DAMA in April 1996 on a global transponder on the INTELSAT 605 at 24.5° east covering its Atlantic Ocean region. This means that all gateway stations equipped with DAMA will be able to communicate with each other. Implementation of DAMA service in the Indian Ocean and Pacific Ocean regions is expected shortly thereafter. DAMA will benefit all users of the system, particularly those in developing countries. INTELSAT expects DAMA to be of great benefit in re-establishing communications after natural disasters. By bringing in fly-away transportable antennas, it will be possible to instantaneously re-establish contact with the rest of the world on the DAMA network.

52. In 1959, when Volunteers in Technical Assistance (VITA) was created to provide technical information and assistance to individuals and groups in developing countries, the first inquiries came from Africa. Africa is still the

principal user of the VITA Inquire Service. VITA also supplies information on natural disasters and human-made crises such as civil strife and refugee movements. In 1987, VITA established its Disaster Information Center.

53. One of the services provided by the Center is a telephone hotline. When called on by the Government of the United States of America for assistance in responding to a disaster, within one day VITA activates its telephone bank, selects and trains volunteers, and begins to record offers and donations of medicine and other commodities. The VITA hotline has provided information on civil strife, floods, cyclones, food shortages, earthquakes, droughts and rains in Algeria, Angola, Benin, Burundi, Cameroon, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Liberia, Madagascar, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Somalia, Southern Africa, Sudan, United Republic of Tanzania, Uganda and Zaire.

54. VITA has identified that one of the major needs for development is reliable communications and that the principal global telecommunications operators have little interest in providing service in most developing countries. Therefore, VITA has developed its own communications programmes, which includes LEO satellites (VITASAT), terrestrial digital radio networks (VITAPAC) and electronic mail services (VITANET).

55. The VITA electronic bulletin board, VITANET, is a multi-line, commercial grade system that allows for on-line database searching, access to training materials, computer conferences, on-line surveys and file transfer utilities, all of which are enormously useful during a disaster and for disaster preparedness activities. VITANET software interfaces will make it possible to link the VITA satellite system and packet radio networks, so that fully-automated end-to-end communications are possible. In September 1994, VITA installed its own direct Internet host. To date, the disaster ListServ has 129 subscribers who have received approximately 20,000 documents. In addition, more than 12,000 documents were picked up through the its gopher. The VITASAT global electronic messaging network is a satellite-based communications system for commercial, government and non-profit users worldwide. It utilizes LEO store-and-forward satellites in polar orbit. This system will provide large message and file transfers over 9.6 kilobits per second (kbps) links and offers two basic services: e-mail/fax transmission, and supervisory control and data acquisition.

56. Local people need to be made aware of the situation and local relief agencies, such as fire or ambulance services, need to be alerted. If help is organized by international relief agencies, this should also be known to the local population. There are various methods for broadcasting information to the area affected by a disaster. It is possible, for example, to receive information directly from a satellite or for messages to be passed via cellular networks. However, the equipment to receive such information is normally only available to relatively prosperous sections of the community and as a result the coverage would be somewhat uneven.

57. The most commonly available receiving equipment is the transistor radio. It has been estimated that there are over two billion radios in use, with nearly half of those being in the developing countries. A system that could address a large proportion of these radios seems to have the best chance of achieving a high penetration. Broadcasting directly to these receivers must be done by terrestrial means. This can most conveniently and economically be achieved by use of the FM/VHF bands of frequencies, for which most transistor radios are already equipped. Distribution of the signal to the area concerned is most conveniently carried out by satellite. Existing satellite capacity is available and can be leased for this purpose.

58. The receiving equipment for the satellite signal can be a relatively simple receive-only Earth station with a 2.4 m antenna and a 64 kbps link. WMO already uses such a system and it can easily be extended for disaster applications. The information received by the station can be disseminated directly to the local population through transistor radios or directed to the local emergency services, as appropriate. Each receiver/transmitter combination has a coverage area of 40 kms in diameter in flat terrain.

D. Use of data from remote sensing satellites

59. Remote sensing has become an important source of geographic information on current land cover and land use needed for rational development and sustainable management of agricultural and forestry resources and for environmental protection. It is therefore increasingly used by FAO in its programmes and field projects being conducted on the basis of the recommendations contained in Agenda 21.[1] However, until now, remote sensing has been largely technology-driven. Users have to compromise to fit their information requirements to the parameters of available remote sensing data. Furthermore, the countries that have the most pressing need for remote sensing do not have the resources to build the necessary capacities for its efficient use.

60. The increasing volumes of image data that are generated or the number of image products that are sold should not be used as a measure to gauge the success of satellite remote sensing. The ultimate criterion of its success will be the extent to which remote sensing will have contributed to the quality of life on Earth. Greater international effort should made to apply new remote sensing and GIS capacities where they are needed most: for monitoring environmental degradation and for implementing programmes for the sustainable management of natural resources in order to safeguard them for future generations. Particular attention should be given to the needs of developing countries and to strengthening their national remote sensing and GIS capacities.

61. The Regional Remote Sensing Project (RRSP) of FAO is a component of the Early Warning System for the Southern Africa Development Community (SADC) region. Output from this project is fed into the combined physical and socio-economic data used by the Regional Early Warning Unit (REWU) and the Household Food Security Project. The main objective of the present phase of the project is to strengthen national and regional capabilities in the area of remote sensing for early warning and food security by the establishment of an operational information system. As such, RRSP is developing national capacities for the analysis and interpretation of coarse-resolution satellite imagery and for the subsequent generation of information products.

62. At present, satellite data processed by the project and the resulting information products are sent to the contact points and a number of users in the SADC region using mail courier services. The current phase of the project will see specific attention being given to the transfer of the processing technology to the principal contact points in the countries. To support this, e-mail links are being established between RRSP, REWU and meteorological services in the SADC countries. Finally, the project will establish a low-cost integrated satellite data acquisition system for NOAA and METEOSAT data in Harare.

63. Geologists, engineers, industrialists and planners are now more frequently using remote sensing in the evaluation of hazard situations. In hazard prevention studies, the interpretation of satellite data together with the analysis of geological records make it possible to reconstruct a historical overview of the occurrence of damaging events. This information can be used statistically to make a prognosis of potential risk in the occurrence of a catastrophe or for the production of thematic maps that show the spatial context in which hazards occur.

64. Remote sensing is not only used in preventive studies, but also in the monitoring of dynamic geological processes such as terrain deformation, neotectonic activities and flooding. Recently, a new technique using synthetic aperture radar (SAR) satellite data, called radar interferometry, has been introduced in the analysis of vertical displacement associated with fault movements.

65. On 17 July 1991, ESA launched the first European Remote Sensing satellite (ERS-1), a polar orbiting satellite that constituted a major development in remote sensing applications by providing new tools for assisting in natural disasters monitoring and relief. ERS-2 was launched on 21 April 1995 in order to ensure continuity of data acquisition. However, since ERS-1 is still fully operational, the two satellites are operated by ESA in a tandem mode that provides a unique opportunity for several applications.

66. The two ERS satellites provide a wealth of radar information for many applications. They are both equipped with several microwave sensors as well as an optical radiometer. The main radar equipment is the Active Microwave Instrument (AMI), which can be operated in an imaging mode as a side-looking SAR, thereby providing high-resolution image data in C-band (5.3 GHz) at regional scales. Because microwave radiation suffers very little

attenuation in passing through clouds and rainfall (except very heavy thunderstorms), the ERS-1 and ERS-2 SARs provide images of the tropical areas that heretofore could not be thoroughly mapped with LANDSAT and SPOT because of the constant presence of clouds in the region. Furthermore, the complementarity between optical and radar images of the same area has already proven to be an excellent and powerful tool for advanced applications and an asset in natural disaster monitoring and relief.

67. On a global scale, the ERS-1 AMI SAR is operated as a wave scatterometer over water to generate SAR "imagettes" of 6 km x 5 km along the SAR swath at 200 km intervals. Through the analysis of the imagette spectrum, operational worldwide information on the wave systems, namely wave height and wave direction, is derived. Such products are disseminated within three hours from data sensing to nominated centres through the global meteorological network for subsequent assimilation into numerical analysis and forecast models.

68. The ERS-1 AMI can also be operated as a wind scatterometer to provide wind vectors at the ocean surface on a 25 km grid. Sea surface backscattering signals of radar pulses emitted at three different side-looking angles are measured on board and then elaborated on the ground through a C-band model to generate surface vectors with the same accuracy for conventional ground measurements. Like the ERS SAR wave data, AMI wind vectors are also disseminated operationally through the global telecommunication system. Data from the ERS wind scatterometer are of particular help in the tropical region, in the southern hemisphere and in the northern Pacific Ocean because of the very limited amount of available statistical data on these areas.

69. ERS-1 radar altimeter data provide worldwide surface information. Several measurements are derived at a global scale from backscattered signals of downward emitted radar pulses, including the height of sea and ice surfaces, the height of sea waves and the wind speed at the sea surface. Additional geodetic and climatological information is generated from the former, which leads to the availability of some important climatic change indicators, such as anomalies in ocean topography (e.g. el Niño and la Niña) or in ice melting (e.g. Antarctic caps). The precise range and range rate equipment (PRARE), operational on ERS-2, allows precise orbit calculations to be made and accurate corrections to radar altimeter measurements to be implemented.

70. In addition, ERS satellites carry an along-track scanning radiometer (ATSR), a dual instrument constituted by an optical and a passive microwave radiometer. The optical radiometer on ERS-1 works in four infrared spectral bands, at 1.6, 3.7, 11 and 12 micrometers; three visible channels have been added to the ERS-2 version. Very accurate sea surface temperature measurements are provided globally on a 50 km grid, with an intrinsic original 1 km spatial and 0.1 K radiometric resolution. A dual viewing, oblique at 50 degrees ahead and vertical, together with internal black-body calibration leads to very accurate atmospheric corrections. The visible channels added to the ERS-2 radiometer allow the derivation of vegetation indices. The ATSR Microwave Sounder is a dual frequency passive radiometer, whose data are used primarily to correct radar altimeter measurements and to determine the atmospheric vapour content.

71. High-resolution satellite imagery (HRSI) is an important tool for increasing the efficiency during the planning and implementation phases of refugee work relief operations. Until recently, the highest resolution satellite images commercially available have been 10 m resolution SPOT images. Currently, images with 2 m resolution obtained from Russian military satellites are commercially available. This information can be used to obtain estimates of refugee-camp population, area and growth rates. The interpretation of such high-resolution images should be strongly linked to the United Nations in order to utilize already established communication lines with relief agencies.

72. In the near future, sensors with ground resolution down to 1 m will be commercially available. The data distribution systems of these satellites will be vastly improved in comparison to the present ones. However, an unfortunate trend might be seen in the data distribution plans of some commercial companies that intend to offer exclusive rights to the customers on a first-come, first-served basis, denying access to the images for late customers. It is therefore important for the United Nations to play an active role in forming policies to distribute HRSI.

73. Data from satellite-based radar systems can also be used in many ways for natural hazard reduction. The most conventional use of radar data is the recognition of flooded areas by the dark signature of still water in a radar image associated with the all-weather capability of the instrument. The 1 m accuracy of the models created by ERS-1 data is unmatched by other space-based techniques. The dense spatial samplings (100 pixels/sq km) provided by radar interferometry in the detection of displacements associated with its accuracy (in the range of 3-10 mm) make it an important tool for assessing most natural hazards. This tool could be used as a cheap warning signal in the case of volcanoes, as was demonstrated in the case of the recent activity at Mount Etna. The ERS-1 satellite can also provide the data required for global monitoring of all potentially hazardous volcanoes. Radar interferometry can also contribute to the understanding of earthquakes, especially in poorly equipped areas because it does not require ground instrumentation.

74. Some current limitations of these techniques are linked to the physics of the atmosphere, the contribution of which can only be separated by the analysis of multiple image pairs and the change of the surface state in long periods of time that spoils the interference patterns. A high throughput system such as ERS-1 proved capable of delivering the many images required. Other limitations come from the features of current space-borne radar instruments, which were not designed for this purpose. The experience gained could be of help when designing better systems in the future. However, the built-in design margins of ERS-1 permit its operational use in the field of interferometry, for which it was not initially designed.

E. A global monitoring and warning satellite system

75. The Japanese Space Agency, NASDA, is emphasizing the development of data analysis technology for a variety of applications including natural disaster reduction. For the development of technology for data application in the field of natural disaster reduction, NASDA is considering cooperative research projects, such as the Global Earth Observation System (GEOS), the Advanced Earth Observing Satellite (ADEOS), the Advanced Land Observing Satellite (ALOS), and the Tropical Rainfall Measuring Mission (TRMM), with the international user community for the verification of algorithms to be applied to actual case-studies. NASDA is also planning to reflect user requirements in the field of natural disaster reduction to future programmes.

76. The purpose of the World Environment and Disaster Observation System (WEDOS) and the Global Disaster Observation System (GDOS) of the Society of Japanese Aerospace Companies, Inc. is to provide continuous operational monitoring of the Earth's environment in order to detect and mitigate natural disasters and human-induced accidents. A total of 26 remote sensing satellites will be launched into low altitude, sun synchronous and circular orbits together with 12 (6 in-orbit spares) data relay satellites in geostationary orbit. The monitoring of short-term changes is indispensable to the prevention of disasters and that type of monitoring could be accomplished by using existing technologies. Both systems therefore concentrate on observing environmental changes that occur over short periods (e.g. oil pollution and red tides) and the simultaneous observation of phenomena occurring globally over the surface of Earth (e.g. wind speed and direction of sea surface).

77. Consequently, any location in the world could be observed by WEDOS at least once a day with 20 m resolution; therefore irregularities and environmental changes can be detected immediately. More precise observations of the damaged areas, with 2 m resolution, will also be possible several times a day. GDOS is a modified version of WEDOS, which facilitates the location of disasters and is capable of repeatedly observing a disaster site.

78. The payloads of the satellite segment of both systems would be designed to monitor the land and ocean environment, the geosphere, hydrosphere and meteorological conditions, with the aid of visible, near infrared, microwave, short-wave and thermal radiometers, synthetic aperture radar, radar altimeter and scattering lidar. The ground segment would comprise a mission management centre, satellite control centres, a master ground station and local user stations. Observation data would be received by the master ground station via data relay satellites and would then be recorded and processed. The processed data would be distributed to each local user station in the world. To implement any of these two systems it is mandatory to develop an international consensus on the importance of the subject of disasters and to gain support from the general public, scientific community, governmental and United Nations entities that are in charge of the natural environment and disaster prevention.

Notes

[1]*Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992* (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: *Resolutions Adopted by the Conference*, resolution 1, annex II.

Annex I

PROGRAMME OF THE WORKSHOP

Time	*Subject*	*Speaker*
	Chairman: Prof. C. J. Chetsanga (Zimbabwe)	
Monday, 22 May		
0900-0945	Opening ceremony	UN, ESA, Zimbabwe
1000-1030	Keynote address Effects of disasters on modern societies	J. C. Scott, IDNDR
1030-1100	Keynote address Role of space technology in disaster assistance	M. Fea, ESA
1100-1115	**Break**	
1115-1200	Southern Africa: Challenges for Long-Term Disaster Reduction: elements of telemedicine	A. Holloway, International Federation of Red Cross and Red Crescent Societies
1200-1330	**Lunch**	
	Chairman: Dr. M. Fea (ESA)	
1330-1415	FAO activities related to environmental disasters	G. Farmer, FAO
1415-1500	Space techniques to confront geological hazards	R. Missotten, UNESCO
1500-1515	**Break**	
1515-1600	GIS and remote sensing in Zimbabwe	D. T. Semwayo, ERSI
1600-1645	Space techniques to combat drought and desertification: an overview	H. Beukema, UNEP
Tuesday, 23 May		
0900-0945	Use of ERS-1 data for disaster mitigation	M. Fea, ESA
0945-1030	Application of radar interferometry Using ERS-1 satellite data	D. Massonnet, CNES France
1030-1045	**Break**	
1045-1130	Remote sensing component of the early warning system for SADCC countries	G. Farmer, Dept. of Meteo Services Zimbabwe
1130-1215	The use of remote sensing technology in combating forest fires.	W. Rugumanu, University of Dar-es-Saalam Tanzania

Time	*Subject*	*Speaker*
1215-1345	**Lunch**	
	Chairman: Dr. W. Botha (South Africa)	
1345-1430	Remote sensing satellites for disaster reduction	L. Walter, NASA USA
1430-1515	Globalstar for disaster communications in Africa	W. Thatcher GLOBALSTAR
1515-1530	**Break**	
1530-1615	The use of Inmarsat in disaster-relief operations	E. Staffa, Inmarsat
1615-1700	Inmarsat-B and -M terminal demonstrations	Inmarsat/AVITRONICS
	Chairman: Miss L. Muvoti (Zimbabwe)	
Wednesday, 24 May		
0900-0945	An overview of remote sensing in South Africa with emphasis on agricultural applications	N. C Badenhorst T. S. Newby Agricultural Research Council, South Africa
0945-1030	Earth observation satellite programmes in Japan for natural disaster reduction	T. Igarashi, NASDA Japan
1030-1045	**Break**	
1045-1130	WEDOS: A world environment and disaster observation system GDOS: A global disaster observation satellite system	T. Kuroda, SJAC/NEC Corp., Japan
1130-1215	Using high-resolution satellite images to monitor "refugee movement"	E. Bjorgo, Nansen Env. & R. Sen. Centre Norway
1215-1345	**Lunch**	
	Chairman: Mrs. A. Howman (South Africa)	
1345-1430	Desertification control in Ghana	G. T. Agyepong University of Ghana Ghana
1430-1515	Space techniques to combat hydrological hazards	L. Walter, NASA USA
1515-1530	**Break**	

Time	*Subject*	*Speaker*
1530-1615	VITA Disaster Information Centre	J. Sedlak, VITA (USA)
1615-1700	Discussions	
1830-2000	**Reception**	Government of Zimbabwe
	Chairman: Prof. S. Ogedengbe (Nigeria)	
Thursday, 25 May		
0900-0945	Assessment and initial communications strategy for post-disaster coordination using satellites	C. Hughes, ESA/ESTEC
0945-1030	Resilience of satellite communications systems in a disaster situation	John Akumu, INTELSAT
1030-1045	**Break**	
1045-1130	Practical uses of satellite terminals for disaster relief operations and the establishment of such facilities at the national level	J. C. Scott, UN/DHA
1130-1215	Necessary capabilities for addressing disaster mitigation and reduction	A. A. Abiodun, UN/OOSA
1215-1345	**Lunch**	
1345-1700	Working group (discussions)	
1830-2000	**Japan evening**	
Friday, 26 May		
0900-1200	Technical visitations Environment and remote sensing institute - ERSI and SADC/FAO Early Warning Unit	 Zimbabwe
1400-1700	Discussion and adoption of the recommendations	
1700-1730	**Closure**	United Nations/ESA Zimbabwe

Annex II

WORKING PAPER ON DATA SUPPLY
(GROUP A)

Objectives

(a) Acquisition of the right data (type, format, supporting medium) and their delivery in a timely fashion.

(b) Establishment of multidisciplinary database(s), including purchasing, operating, maintaining and upgrading of the appropriate facilities needed for the scope.

Issues

Funding (cost)

Adequate and sustainable funding for facilities and training.

(a) Earth observation data

With respect to meteorological satellites, data gathering is routinely performed as a normal operation, but one issue is the planned encryption of METEOSAT data by EUMETSAT, with the consequent cost of the encryption software key.

With respect to high resolution satellite data, the cost is considered too high for the systematic acquisition to support prevention; data must be paid for even for coverage related to a natural disaster.

Funding for data archiving should also be identified.

(b) Communications

Operational and maintenance costs associated with data acquisition.

Operational and maintenance costs required to ensure the timely delivery of data to users.

SAT regulations.

Technology

Earth observation

Availability of suitable hardware and software packages (including licences) for acquisition, archiving, pre- and basic processing, distribution display and stable power supply. These must include upgrading as required.

Communications

Choice of the system(s) to be used.

Quick delivery of data can become a problem in case of emergency.

Expertise

Earth observation and communications

Adequate specialized training.

Technical expertise in data handling and in maintenance.

Retention of qualified and experienced manpower.

Public communication

Earth observation and communications

Political commitment for supporting and funding data supply activities is needed because such activities are usually proportional to the interest in the information that is generated from the data themselves.

Mechanisms needed for achieving objectives and tackling issues

A prerequisite is a thorough analysis of needs and goals against the actual situation at the national level. Regional and/or international cooperation should be sought, in particular in domains such as cost sharing, training, thematic workshops and seminars, and technical awareness.

A. Funding

(a) Earth observation and communications
National commitments to be reflected in the relevant budget lines
Other funding sources to be explored
Private institutions in the national context should be approached.

B. Technology

(a) Earth observation
Countries must express data supply requirements in order to ensure data availability.

(b) Communications
Countries should address the amendments to data regulations in order to allow data availability as needed.

C. Expertise

(a) Earth observation and communications
Ensure thematic on-the-job training
Ensure adequate training for trainers.

Recommendations

General

In view of the importance and utility of Earth observation data in general, political commitment is needed to ensure adequate and sustainable support to data supply activities; priority should be given to ensure the timely distribution of data with special dispensation from the ministry of postal, telephone and telegraph (PTT) during critical periods

Specific

Full ground station coverage of the African continent should be ensured for high resolution satellite data.

Data should be made available free of charge to relevant disaster management institutions on the occurrence of sudden short-term natural disasters, such as floods, earthquakes, volcanic eruptions, land/mud-slides, weather storms and oil spills.

Meteorological satellite data encryption should be waived for use by relevant public institutions.

Annex III

WORKING PAPER ON INFORMATION GENERATION (GROUP B)

The assumption is made that data are available and supplied. We undertake:

Processing	Dissemination of raw and value-added data
Analysis	
Data integration	
Interpreting	Development of techniques and methodologies
Identify user needs	

Issues

Funding

Identify role of players

Identify areas requiring funding, including:

Equipment	Research and development
Software	Maintenance
Personnel	Information dissemination
Facilities	Field verification
Data supply	Training
Products	Consultants
Communications links	

Cooperative studies
Sponsorship - applications
Ensure government budgeting
Project proposals
Undertake marketing campaigns
Introduce cost recovery methods.

Technology

Identify and acquire appropriate equipment
Develop data transfer protocols
Ensure compatibility of systems
Ensure reliable, timely, resilient, affordable, efficient telecommunications links
Advise on database structures
Maintenance and support to ensure sustainability
Optimum utilization of hardware and software
Development and identification of appropriate/desired techniques and methodologies
Ensure application of techniques.

Expertise

Identify tasks
Find appropriate personnel
Provide bursaries for technical education and continued training

Develop in-house technical training programs and identify external training facilities
Improve conditions of service
Ensure career paths
Maintain critical mass: avoid one-person shows, ensure back-up support
Keep abreast of technological developments
Establish regional training centres
Produce user manuals.

Public communications

Aim to produce user-friendly products for professional and general public
Promote proactive awareness programs (and credibility of disaster managers)
    Professional
    Public
    Key decision makers
Ensure targeted communications of information
Produce pamphlets etc.
Take into account culture and language
Identify communications protocols
Identify and utilize all communications links, including: PTTs, TV, radio, newspapers, leaflets, electronic mail and Internet
Disseminate user-friendly information
Develop a national education curriculum.

Recommendations for a practical programme

Establish steering committee
Perform needs analysis
Carry out inventory of existing status: what's happening, funding, personnel, systems and data availability, and data dissemination
Identify what procedures are required
Develop plan of action, proposal, budget
Obtain implementation and budget approval
Establish facilities
Develop capability and become operational
Ensure sustained operations
Carry out progress evaluation.

Annex IV

WORKING PAPER ON DECISION PROCESS (GROUP C)

Objective

To highlight the guiding principles with regard to the decision-making processes required for the optimal application of remote sensing and communications technology in disaster management.

Issues

To establish a high level coordinating body for disaster management.

To establish an interdisciplinary focal point for each department both internationally, nationally, regionally, subregionally and locally.

To prepare an effective national disaster management plan to identify disaster types (i.e. drought, floods, cyclones, locusts and refugees) and assign appropriate responsibilities to organizations such as government departments, ministries, non-governmental organizations, communities and individuals. The ultimate responsibility lies within the government. A disaster management plan should comprise preparedness, mitigation, relief and recovery, and the funding thereof.

A disaster management plan should address: capacity building, civic education, training, communications elements and the role of women.

Recommendations

Countries should modify national legislation to allow proper functions of disaster mitigation, including areas such as telecommunications policy, movement of technology, free flow of information within the country and across its borders, as appropriate.

Governments should promote bilateral and multilateral agreements concerning, for example, data equipment and telecommunications.

National governments should be encouraged to take disaster mitigation problems seriously and include the needs of disaster management in their national budget.

Specific decisions should be taken at appropriate levels commensurate with the task and expertise required.

Experience with disaster management gained by certain countries should be utilized, for example Malawi, South Africa and Zimbabwe, because each has an established disaster management plan.

Space-based technologies, such as remote sensing and satellite communications, should be used to the extent possible to focus risk assessment, identification of vulnerable areas, suggest preventive measures and monitor events.

Countries should maintain and strengthen cooperation with established agencies, for example, ESA, NASA and NASDA, and coordinating bodies, such as the United Nations, Office for Outer Space Affairs, and the telecommunications companies where applicable.

Regarding funding, it is understood that regional, national and local governments must rationalize a strategy for funding disaster management planning. Such a strategy must include a significant commitment on the part of these governments to support essential initiatives. It is also understood that the costs of infrastructure building, both in technological and human terms, is expensive, and donor governments and international funding agencies will be looked to for support in terms of technical assistance, education and training and, when necessary, financing. In this respect the workshop endorses the report of the International Decade for Natural Disaster Reduction's *Yokohama Strategy and Plan of Action for A Safer World, Guidelines for Natural Disaster Prevention, Preparedness, and Mitigation,* especially item 13, and all its sections.

Annex V

WORKING PAPER ON IMPLEMENTATION/EXECUTION (GROUP D)

Key activities are directed towards:

GOAL: to achieve sustainable development and socio-economic recovery following a disaster.

Prevention	Relief
Preparedness	Rehabilitation/reconstruction

Objectives

Communicate the plans across effective parties; monitoring the plans; execution of the plans; and evaluation of the plans and feedback.

Issues

Identification of the stakeholders in the disaster.

Identification of appropriate means of communication.

stakeholders acceptable packaging of information on plans.

Resources inventory and assessment.

Training programmes for stakeholders (e.g. on fire, floods).

Performance criteria.

Formulating remedial process.

Capability to evaluate the plans

Mechanisms

Establishment of an implementing authority and clear chain of command, to ensure ownership and responsibility for the execution of a disaster management plan.

Development and installation of appropriate communication network.

Establishment and implementation of participatory communication mechanism.

Setting up administrative mechanism for establishment and maintenance of physical and financial resource databases and decision - information databases.

Development and implementation of suitable training programmes (including technical training, managerial training and project planning training).

Development and implementation of participatory process for setting performance criteria.

Establishment and operationalization of the monitoring team.

Development and implementation of participatory evaluation mechanism including feedback.

Recommendations

Encouragement of formation of indigenous non-governmental organizations focusing on disaster management.

Establish national institutions for disaster management (e.g. Prime Minister's office).

Development of a programme to ensure routine accessibility to disaster decision - support information (e.g. remote sensing data, weather data and demographic data).

Development of guidelines for the installation of communication networks to ensure compatibility within the SADC subregion.

To task a United Nations agency to research and develop manuals and guidelines for disaster management (e.g . participatory communication mechanism for disaster management; administrative mechanism; resource databases and decision information database).

FAO/SADC Food project should be reformulated to include disaster management in general.