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REPORT ON THE UNITED NATIONS/EUROPEAN SPACE AGENCY REGIONAL CONFERENCE ON SPACE TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT AND COMMUNICATIONS

(30 October-3 November 1995, Puerto Vallarta, Mexico)

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INTRODUCTION

A. Background and objectives

1. The General Assembly, in its resolution 37/90 of 10 December 1982, decided, upon the recommendation of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82),[1] that the United Nations Programme on Space Applications, *inter alia*, should organize meetings on advanced space applications and new system developments for managers and decision makers in the area of space application and technology development activities and for users of such technology and should promote greater cooperation in space science and technology between developed and developing countries as well as among developing countries.

2. The Committee on the Peaceful Uses of Outer Space at its thirty-seventh session, held in June 1994, endorsed the programme of United Nations workshops, training courses and seminars proposed for 1995, as outlined by the Expert on Space Applications in his report (A/AC.105/555, paragraph 62).[2] Subsequently, the General Assembly, in its resolution 49/34 of 9 December 1994, endorsed the United Nations Programme on Space Applications for 1995.

3. In response to General Assembly resolution 49/34, and in accordance with the recommendations of UNISPACE 82, a United Nations/European Space Agency Regional Conference on Space Technology for Sustainable Development and Communications was organized, within the framework of the activities of the Programme for 1995, for the benefit of countries in the region of the Economic Commission for Latin America and the Caribbean.

4. The Conference was organized jointly by the Office for Outer Space Affairs of the Secretariat, the European Space Agency (ESA), the Instituto Mexicano de Comunicaciones and the Instituto de Geografía, Universidad Nacional Autónoma de México.

5. The objectives of the Conference were: (a) to examine how space technology could support the planning and executing of sustainable development programmes or projects; (b) to discuss the existence, or need for the establishment, and utilization of global and regional environmental information systems; and (c) to examine the role of satellite communications in the generation and delivery of information and services, including those needed for rural communications, education and health care, as well as for the prevention and mitigation of the effects of natural disasters.

B. Organization and programme of the Conference

6. The Conference was held from 30 October to 3 November 1995 at Puerto Vallarta, Mexico. The Conference was scheduled to take place the week before the VII Latin American Remote Sensing Association (SELPER) Symposium, held at Puerto Vallarta from 5 to 10 November 1995. This coordination enabled some participants from Latin America and the Caribbean, whose travel was provided by the co-sponsors of the Conference, to participate in the SELPER Symposium at minimal expense to their institutions.

7. The Conference was attended by 66 participants. Participants came from the following countries: Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Guyana, Mexico, Panama, Trinidad and Tobago, Uruguay and Venezuela. The following organizations and institutions were represented: International Telecommunication Union, ESA, Inter-American Development Bank, International Mobile Satellite Organization (Inmarsat), International Telecommunications Satellite Organization (INTELSAT), Agencia Espacial Brasileira, Canada Centre for Remote Sensing, National Oceanographic and Atmospheric Administration (NOAA) of the United States of America, Nuova Telespazio of Italy and RADARSAT International of Canada. Financial support to defray the cost of air travel and living expenses of 31 participants was provided by the United Nations, ESA and the Instituto Mexicano de Comunicaciones. The expenses for speakers and other participants were defrayed by their own institutions.

8. The programme of the Conference (see the annex to the present report) was developed jointly by the Office for Outer Space Affairs, ESA, the Instituto Mexicano de Comunicaciones and the Instituto de Geografía, Universidad Nacional Autónoma de México. Through technical presentations and working group discussions, the participants received the most recent information on the vital role that Earth observation and communication satellites could play in the timely collection and dissemination of data and information, providing valuable, sometimes crucial, input for planning and executing operationally viable strategies for sustainable development such as those contained in Agenda 21.[3]

9. The presentations and discussions at the Conference also dealt with the important role that communication satellites could play in improving the economic and social welfare of a country. This capability is being utilized in improving telephone communications, as well as in transmitting entertainment, health and educational programmes, particularly to rural areas. New areas of communications technology include the mobile communications and global positioning systems, both of which will have a strong impact on national economies. Communication satellites, particularly in combination with data from Earth observation satellites, will increasingly be used in establishing systems for preventing or mitigating the effects of natural disasters.

10. The present report, which covers the background, objectives and organization of the Conference, in addition to presenting the observations and recommendations of the Conference and a summary of the technical presentations, has been prepared for the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. The participants in the Conference reported on the knowledge that they acquired and on the work conducted during the Conference to the appropriate authorities of the Government, universities and research institutions in their respective countries.

I. BACKGROUND ON SUSTAINABLE DEVELOPMENT

11. Sustainable development is understood to mean development that meets the needs of the present without compromising the ability of future generations to meet their own needs (A/42/427, annex, Overview, paragraph 27). The world, however, is confronted with increasing hunger, poverty, illiteracy, ill health, natural resource depletion and destructive human activity, which tend to dispel the applicability of this maxim. The ecological and economic repercussions of ozone depletion, the greenhouse effect and climate change, soil and forest degradation, the decline of biological diversity, and the increasing pollution of land, water and air are stretching the life-sustaining mechanisms of Earth to their limits.

12. The most important challenges to continuous and sustainable development that humanity will face in the near future will be the provision of basic necessities, such as food, shelter, a clean and healthy environment and proper education, to the growing population of Earth. Of the more than 5 billion people who currently inhabit the Earth, 1 billion, mostly in developing countries, do not have access to clean drinking-water and over 1.7 billion do not have access to adequate sanitation. Moreover, it is estimated that in the next 25-40 years, the population of the Earth will surpass 9 billion.

13. Because industrial and agricultural activities on the Earth's environment have reached such a level that their effects are clearly observed on a global scale, continuous and sustainable development action and policies should be carried out for the protection and maintenance of Earth's natural environment. A good knowledge of the Earth environment is needed to develop national and international policies that can solve environmental problems and to properly manage limited natural resources.

14. Natural disasters have direct economic costs amounting to billions of United States dollars per year. Besides the loss of human lives and suffering, these events disrupt the normal flow of economies and require enormous amounts of financial resources that could otherwise have been channelled into development. Usually the developing countries are least prepared to minimize and repair the damages and to provide the necessary emergency relief.

15. Countries faced with these economic and social problems must not only formulate plans of action that promote important production objectives and improve existing human conditions, but must also attempt to provide contingency plans for future growth and further stress on already deficient infrastructure.

16. A process of re-examining and redefining development is taking place at the United Nations. Through a cycle of world conferences, consensus is being built around essential development values. At the United Nations Conference on Environment and Development, held at Rio de Janeiro, Brazil, from 3 to 14 June 1992, the links between the environment and development were established. The World Conference on Human Rights, held at Vienna from 14 to 25 June 1993, reaffirmed the right to development as a basic human right. The International Conference on Population and Development, held at Cairo from 5 to 13 September 1994, indicated that population growth could be an asset or an obstacle to development, depending on whether it was left unchecked. The World Summit for Social Development, held at Copenhagen from 6 to 12 March 1995, addressed poverty and unemployment, while the Fourth World Conference on Women: Action for Equality, Development and Peace, held at Beijing from 4 to 15 September 1995, addressed the integration of women into development and women's rights. All these issues are part of development in the emerging United Nations definition.

17. In his report entitled *International Cooperation in Space Activities for Enhancing Security in the Post-Cold War Era* (A/48/221, paragraph 17), the Secretary-General stated that it might be the time to examine ways to formalize international cooperation in the utilization of space systems and space technology for environmental purposes, particularly the implementation of the programmes recommended in Agenda 21, to ensure that all countries could obtain the information they needed to participate fully in the collective international effort. It might also be said that it is time to examine how the use of space technology can contribute to the goals of the above-mentioned world conferences.

II. OBSERVATIONS AND RECOMMENDATIONS

18. With the above-mentioned concepts in mind, the Conference discussed the following issues: (a) identifying appropriate technologies, techniques and data to support the planning and execution of projects; (b) developing awareness among decision makers of the cost-effectiveness of using space technology; (c) establishing follow-up networks and mechanisms for the exchange of information; and (d) education in space science and technology. The discussions covered the use of satellites for Earth observation and communications.

19. In their observations and recommendations, which are presented below, the participants identified current situations and indicated the policies and action that should be supported by governments, national and international institutions and the scientific and technical communities to foster favourable conditions for the use of space technology in support of sustainable development.

A. General observations and recommendations

Observations

20. The Conference noted that, for a number of reasons, there was wide variation in the available resources and technological capabilities for using space technology among countries in Latin America and the Caribbean. That applied to the use of Earth observation satellites for natural resource and environmental applications and the use of communications satellites for disaster prevention and relief and for the provision of basic services such as voice, video and data transmission for commercial purposes, rural education and rural health assistance.

21. Better coordination of national space-related activities and increased awareness among countries of ongoing regional and global space-related programmes would result in their greater participation in those programmes and other space activities, making more direct and indirect benefits available to all countries. It was noted that some

countries had established or were in the process of establishing space agencies and that some countries had national space committees while others functioned through ad hoc mechanisms.

22. The promotion of policies and actions leading to global sustainable development ought to be the concern of all countries. Data and information from all countries in the region, including those with the least developed space-related capabilities, were needed to study the current state of and changes in the environment.

23. In order to support the use of space technologies in sustainable development programmes or projects and in the diverse applications of satellite communications, all countries in the region needed to educate and train professionals and technicians in the fundamental and practical aspects involved in those technologies.

Recommendations

24. States without a national entity to coordinate activities, to disseminate information and to advise on technical space matters should consider the desirability of establishing one.

25. Regional priorities for technical cooperation should be identified; a survey of the state of space-related development of each country should be conducted at the national level in order to serve as a catalyst to enhance such cooperation and to promote the development of the least developed sectors and of those with the least installed capacities, bearing in mind the following:

(a) The survey should include space-related national organizational structures, if any, and should identify:

(i) National entities involved in space activities;

(ii) Priority areas for space applications;

(iii) Installed capacity in priority areas including main facilities for receiving and processing satellite data or for communications (satellite or ground-based);

(iv) Ongoing international cooperation programmes or projects;

(v) The existence and/or needs concerning qualified human resources, hardware and software;

(b) The results of the survey should be widely disseminated in order that countries, institutions and individuals could identify potential cooperation partners;

(c) Such a survey should be promoted by the United Nations with the assistance of space institutions in the region and interested international space agencies such as ESA.

26. The indigenous development of space technologies in the region, particularly through regional and international cooperation, should be strenghtened.

Conference participants from several institutions (i.e. Universidad Nacional de San Juan, Argentina; Asociación Boliviana de Teledetección para el Medio Ambiente; TeleBras; Agencia Espacial Brasileira; Universidad Católica de Chile; Comité de Actividades Espaciales of Chile; Instituto Geográfico Nacional of Costa Rica; Instituto de Geografía Tropical of Cuba; Instituto Mexicano de Comunicaciones; and Ministerio del Medio Ambiente y Recursos Naturales Renovables of Venezuela) identified the following areas for regional cooperation involving institutions (other participants indicated interest in such cooperation but did not identify specific areas):

> Integration of remotely sensed data; training in data processing and meteorological modelling; facilitating satellite data collection; working jointly on space propulsion systems, environmental impact, land degradation and desertification; integrating regional cooperative space applications projects; coastal

and fishery applications; establishing benchmarks and testing connectivity devices in communication networks; and development and applications of new technologies for transmission of digital information.

27. A simple and non-expensive mechanism should be established to facilitate follow-up to recommendations made at various regional and international meetings of experts and to follow up the specific offers of possible cooperation referred to in paragraph 26 above; one possible mechanism would be as follows:

(a) The establishment of a regional space information network to disseminate information on space-related activities and ongoing projects within and outside the region, thereby serving as a means of coordination of ongoing activities and of promoting awareness of technological developments;

(b) The network could be established through electronic mail, at minimal cost, by establishing its server at a national or international space institution and utilizing existing electronic mail nodes and computer equipment in the region. Where those resources did not exist, they might be obtained through small local investments with the assistance of international funding institutions. For its human element, the network would require that an individual or institution in each country be responsible for periodically updating national information of a general nature on a permanent bulletin board.

28. There should be more education and training opportunities, particularly at the following levels: (a) in-depth education programmes leading to higher academic degrees (Master of Science or Ph.D.); (b) short, specialty or updating courses and workshops on specific project-related themes; (c) training courses for technicians on the use of specialized hardware or software; and (d) workshops lasting from one to three days on the potential and cost-effectiveness of the use of space technology for high-level decision makers and programme managers. Various ongoing national and international efforts should be complemented through regional and international cooperation.

29. The Centre for Space Science and Technology Education in Latin America and the Caribbean, affiliated with the United Nations, should be supported as it would provide in-depth education in all space-related fields. The Centre, to begin in 1996 with nodes in Brazil and Mexico, should, in due course, grow to establish programmes in other countries in order to use the full capacities of the region.

B. Earth observation satellites

Observations

30. The Conference noted that the monitoring and gathering of environmental information were essential in characterizing a region, which was a necessary step in appropriate sustainable development planning and adequate territorial zoning. The use of space technology, including data from diverse types of sensors and advanced satellite communications capabilities, could facilitate the timely and low-cost gathering of environmental and natural resource data.

31. Once data were acquired by a satellite there was often a need to transmit such data to a functional ground-based satellite receiving station. If that could not be done (many satellites did not carry on-board recorders) the information would be lost. To a large extent, that was the current situation in Central America, parts of the Caribbean and the north-west portion of South America, which were covered by the satellite ground receiving station located at Cotopaxi, Ecuador. Other gaps in data coverage existed in the region. The Conference noted that efforts were currently being conducted through an Andean Group initiative to enable the regular operation of the satellite ground receiving station at Cotopaxi.

32. The main obstacles to utilizing satellite data in the region were the access to and high cost of the data and not having a sufficient number of qualified professionals and technicians in the relevant disciplines. Difficulties in demonstrating to high-level decision makers in developing countries that the use of space technology could be cost-efficient and could produce better and more timely results were intrinsically associated with those obstacles.

33. It was also necessary to convince decision makers that an investment in the necessary equipment, data acquisition and training of qualified personnel for the operational use of satellite data would not need to be repeated in the short term due to rapidly evolving technologies.

Recommendations

34. Alternative solutions to satellite data reception should be explored in order that valuable environmental data did not continue to be lost. Alternative solutions, which were not mutually exclusive, included the following: (a) the continuous functioning of the satellite ground receiving station at Cotopaxi; (b) the installation of mobile antennas in States that would guarantee their continuous operation and access by all States to the data received; (c) the promotion among the satellite operators of greater use of on-board data recorders; and (d) the promotion of further support from international institutions and from the satellite operators for the satellite-receiving network of ground stations as sources of data for protecting the environment.

35. Data formats should be standardized for all satellite systems, and space agencies should guarantee the continuous operation of their satellite systems in accordance with established parameters and data standards. The work of the Committee on Earth Observation Satellites should be encouraged and supported.

36. A permanent programme for the systematic integral protection of the environment should be created at the regional level, bearing in mind the following:

(a) Such a programme should be associated and should work closely with the United Nations Environment Programme and with the International Geosphere-Biosphere Programme to address issues of a regional nature;

(b) The proposed programme would not need to be costly. It would involve dissemination of information of recent, ongoing or proposed environment-related activities that could lead to joint or coordinated independent actions. The exchange of experiences would also support sustainable development policies in countries in Latin America.

C. Communications satellites

Observations

37. The Conference noted that disasters of natural or human origin, including environmental degradation were among the greatest obstacles to sustainable economic and social development. In both situations, Earth observation and communications satellites could be used to great advantage for preventive and mitigation purposes. Fixed and mobile communications satellites could provide the necessary means for disaster early warning systems. Through the use of portable antennas or mobile communication units, the capability existed to restore in just a few hours vital communications connecting a disaster area to relief headquarters and to the outside world.

38. Mobile satellite communications systems, domestic, regional and international, provided a robust and cost-effective means of re-establishing immediate communications in case of emergencies for the disaster relief operations. Such systems could also be used to monitor environmental, seismic and meteorological variables for early warning or scientific purposes.

39. Considerable expertise in the use of mobile and fixed communications systems already existed in many countries in Latin America and the Caribbean. That expertise was a good basis on which to build the telecommunications support needed by civil defence and emergency relief institutions. That expertise could be augmented, and (in countries where it did not exist) built, by training provided by international organizations with experience in the relevant application fields.

40. Establishing a telecommunications capability, whether land-based or satellite-based (or a hybrid of the two), was becoming essential to meet the basic needs of a developing society. That capability could provide the means

for normal telephone communications and commercial, entertainment and educational transmissions, in addition to reducing the cost of, or making possible, basic education and health services for rural populations.

Recommendations

41. In order to be prepared for the occurrence of a disaster, all Governments in Latin America and the Caribbean had national disaster and emergency relief plans; however, satellite technology was often not used to the extent possible. In such cases, Governments should prepare comprehensive plans for the use of telecommunications, including the use of fixed and mobile satellite communications systems, in their national disaster and emergency relief plans.

42. In order to implement those plans, the funding required to acquire the equipment and for training in its use should be included in the national budgets for that sector. Where needed, additional funding should be sought from international funding institutions such as the Inter-American Development Bank.

43. In the case of mobile communications equipment, a more recent technology, the relevant existing laws and regulations should be reviewed and modified with the aim of allowing the equipment to be moved at short notice in cases of emergency. To promote the acquisition and routine use of such equipment, customs duties, licensing and setting of tariffs should reflect the high social value of the equipment for monitoring and early warning systems.

44. A specialized forum should be established, possibly within the United Nations system, to discuss the range of mobile and fixed communications applications that could support the new national and global economic policies and to provide integral solutions aimed at specific economic sectors. That implied that communications facilities should be complemented with value-added services as a multiplying factor for the impact that they could have on economic development.

45. There was clear support from financial support agencies in helping States to be better prepared to cope with natural disasters; however, there was also a lack of coordination in the provision of some fundamental elements to facilitate that task, namely, research and access to adequate technology. The United Nations should play a crucial role in bringing together the many actors whose participation was required in order to improve the world's capability to deal with natural hazards and disasters.

46. The United Nations should undertake the following: (a) enhance the database on natural hazards and the human-made conditions having a bearing on them, with special emphasis on high-risk locations; (b) facilitate sustained access of developed and developing countries to satellite-derived information to complement ground monitoring services; (c) develop means to effect the transfer of appropriate technology and financial support to the developing world, with specific applications in natural disaster prevention and mitigation; and (d) make natural hazard management an integral part of sustainable development efforts.

III. FOLLOW-UP ACTIVITIES

47. During the Conference the representative of ESA had offered to explore the possibility of establishing such an information network at the European Space Research Institute (ESRIN) facility of ESA at Frascati, Italy.

48. Further to the proposal announced by the ESA representative during the final discussion at the Conference, work was started at ESRIN in December 1995 with the aim of providing an initial focal point for the quick and informal exchange of information to be made available to all who had participated at the Conference. In order to ensure that similar opportunities are offered to all participants, the strategy being implemented entails the use of ESRIN communication facilities in the following way:

(a) Creation and updating of a dedicated homepage on the ESA/ESRIN World Wide Web (WWW) network (http://www.esrin.esa.it/);

(b) Simultaneous telefax or air mail distribution of that WWW information to participants not having access to electronic mail, using telefax transmission wherever possible;

(c) Setting up of a server to allow contributions from participants to be collected and viewed by others;

(d) Inclusion of contributions from the participants in the WWW homepage and their distribution via telefax and air mail;

(e) General use of the English and French languages, to comply with ESA rules.

The existing electronic mail link between the Office for Outer Space Affairs at Vienna and ESA/ESRIN at Frascati will ensure simultaneous communication with both institutions.

49. The WWW homepage service is expected to start in February 1996; the first information note will be distributed to all participants of the Conference via telefax and air mail at the beginning of March 1996. In a second step, the above communication tools will be made available to all participants of United Nations/ESA workshops and courses on the use of Earth observation satellite data and their applications to environmental and development issues, as well as to disaster relief and mitigation.

IV. SUMMARY OF PRESENTATIONS

A. Earth observation satellite systems

50. It was stated at the Conference that the Earth observation programme of ESA included both meteorological and high-resolution systems. The pre-operational meteorological programme had begun in 1977 and included Meteosat-1, Meteosat-2 and Meteosat-3, while the operational programme included Meteosat-4, Meteosat-5 and Meteosat-6. Since 1 November 1995 the Meteosat programme had been operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), a European consortium, while ESA would continue to build and launch future spacecraft of the series. Meteosat-7, scheduled to be launched in 1997, would mark the transition to Meteosat Second Generation. The first of the series of second generation satellites was scheduled for launch in the year 2000.

51. The first satellite of the European Remote Sensing Programme (ERS-1), launched in 1991, carried several microwave sensors on board. Its primary instrument was the active microwave instrument (AMI), which could provide high-resolution images (in C-band) and wind speed through ocean wave spectra analyses. While in an imaging mode, AMI covered a swath of 80-100 km, with a resolution of the order of 27 m in the range direction and 29 m in the azimuth direction. Operating in wind mode, AMI covered a swath of 400-500 km over the ocean with resolution cells of 50 km and measured wind speed in the range of 4-24 m/s with an accuracy of 0.5-2 m/s.

52. ERS-1 also carried a radar altimeter that operated at a wavelength of 2 cm. The altimeter was used to measure average wave height and wind speed and to determine meso-scale ocean topography. Data from the altimeter had been used successfully to determine ice type and topography, as well as water and ice boundaries.

53. A third instrument on board ERS-1 was the along-track scanning radiometer (ATSR) that operated in three bands in the thermal region of the electromagnetic spectrum. The bands were centred around 3.7, 11 and 12 micrometres. The ATSR looked through the atmosphere at the surface of the ocean from two directions, downwards vertically and at an incidence angle of 50 degrees. The difference between the oblique and vertical measures provided information on atmospheric absorption while the differences between measurements at the three wavelengths were used to determine atmospheric water vapour content.

54. The second satellite of the ERS programme (ERS-2) was launched on 21 April 1995 and was placed in the same orbit as ERS-1, following it with a difference of 31 minutes. As the satellites were being operated in tandem, ERS-2 could visit a site 24 hours after ERS-1. Such an arrangement allowed interferometric analysis that produced digital elevation models with a precision measurable in centimetres of the terrain being imaged. In addition to the instruments carried by its predecessor, ERS-2 also carried Global Ozone Monitoring Equipment. However, the ATSR instrument on board ERS-2 operated in the visible portion of the electromagnetic spectrum.

55. Although originally designed for ocean and ice applications, synthetic aperture radar (SAR) images obtained by ERS-1 and ERS-2 had been tested, with varying degrees of success, in agriculture, forestry, hydrology, cartography and geology and in monitoring natural hazards such as floods and mud-flows. Near the coastline, SAR images had also found applications to aquaculture, mangrove forestry and coastal monitoring. As such, they had become valuable data-gathering satellites to support environmental monitoring and sustainable development programmes.

56. The ENVISAT-1 satellite was envisioned as an enhancement of the ERS programme. However, in addition to contributing to environmental studies, the satellite would be an important tool for marine biology and atmospheric chemistry studies. Its instruments would include advanced synthetic aperture radar, a Global Ozone Monitoring by Occultation of Stars instrument, a medium resolution imaging spectrometer, a Michelson interferometer for passive atmospheric sounding, a radar altimeter (RA-2) and an advanced along-track scanning radiometer.

57. Canada's Radarsat had been launched on 4 November 1995 carrying a SAR instrument on board that would operate in C-band with multi-mode single polarization. Its polarization would be horizontal-horizontal (the terminology referred to the orientation of the microwave energy transmitted and received by the satellite's antenna). The polarization property of microwaves was very useful in differentiating objects on the ground, as surfaces reflect differently depending on the polarization of the incident energy.

58. Radarsat would have the capability of imaging swaths 50-500 km in width with associated resolutions of 10-100 m. The instrument was designed with capabilities for the following five operating modes: standard (25 x 28 m resolution, 100 km swath), wide swath (25 x 28 m resolution, 150 km swath), fine resolution (11 x 9 m resolution, 50 km swath), ScanSAR (50 x 50 m and 100 x 100 m resolutions, 300 and 500 km swaths) and extended (10-20° and 50-60° incidence angles, 25 x 28 m resolution).

59. The spacecraft, designed for a five-year lifetime, was in a Sun-synchronous orbit, dawn-to-dusk, with a 24-day repeat visit period and a three-day subcycle. The SAR antenna would point north but the spacecraft was capable of rotating 180° about its yaw axis in order to obtain full coverage of the Antarctic. Radarsat would operate with its antenna pointing south for a period of two weeks twice a year to allow full imaging of the Antarctic during its maximum and minimum coverage by ice.

60. Because it would carry on-board recorders, Radarsat would be able to provide imagery of the entire globe. The Radarsat instrument would be capable of collecting up to 28 minutes of SAR data during each of its orbits. Radarsat mission operations would be coordinated by a mission management office which would serve as an interface between the user community, the mission control facility and the ground receiving and processing facilities. The mission management office would monitor the entire data distribution, which would be carried out mainly by Radarsat International.

61. The first Brazilian satellite, data collection satellite (SCD-1), had been in orbit at an altitude of 760 km for 16 months. The second, SCD-2, would be similar to the first in its objective but would incorporate technical improvements and was expected to be launched in 1996. Each of the spin-stabilized satellites had an approximate mass of 100 kg. Their mission was to retransmit environmental data obtained by low-cost data collection platforms on the surface of the Earth.

62. SCD-1 was already performing its functions, covering all of Brazil, and had the capability of servicing adjacent areas. Neighbouring States had already expressed their interest in signing cooperation agreements through which SCD-1 data would be made available to them at no cost. The services provided by SCD-1 could be extended to cover all tropical and subtropical areas of the globe. Development work had already started on SCD-3, which, besides functioning as a data collection satellite, would serve to test equipment for mobile communications.

B. Satellite communications

63. It was universally recognized that the information and telecommunications industries were part of the global economy. They both contributed to, and benefited from, growth of gross national product (GNP). It was also generally recognized that there was a correlation (though cause and effect had not been established) between levels of investment in telecommunications and levels of per capita GNP.

64. Nearly two thirds of the current world population did not have access to basic telephone services. In some developing countries telephone density was as low as 0.1 per cent, while in some developed countries it reached 60 per cent. In many developing countries, the majority of telephones were located in cities while, at the same time, the majority of the population lived in small towns and communities. That was a result of the services being offered where there was a demand from segments of the population which represented larger economic and commercial benefits.

65. If the demand for national communications was a derived demand, then its growth was generated by the needs of the economy and society. The same applied to the concept of a global economy and a global society. It had already been recognized in some developed countries that the promotion of systems with only national coverage was not justified. Consideration was being increasingly given to the idea that in order to promote international trade, the development of global transport and telecommunication systems was required.

66. The above assertions appeared to be justified by the fact that telecommunications and information technologies were among the markets with the largest growth. Their expansion was creating growth in the corresponding manufacturing industry, which was an indication of the multiplying effects that those technologies had on other sectors of the productive chain. Indeed, they could become economic engines for other sectors.

67. Satellite communications had evolved very rapidly under the stimulus of important changes in national legislations affecting the communications sector around the world, and particularly in Latin America, aimed at promoting private investment and modernizing the infrastructure so that it could assimilate the rapid technological changes.

68. Fixed and mobile satellite communication systems represented support for the industrial, commercial, service and social welfare sectors. Fixed satellite communications had given noticeable support to the growth of global, regional, national and local networks for government institutions and private enterprises in their daily operations. They were also used in long-distance trunking links and when there was a need to access remote users requiring wide-band digital services.

69. Very small aperture terminal (VSAT) antennas had reduced the complexity and cost of data and information networks. Developments in the areas of VSAT and mobile communication technologies had provided the means for efficient end-to-end services. Those developments, coupled with relatively high costs of using terrestrial circuits, had resulted in a surge of corporate and public communications networks.

70. Mobile satellite communications were still in their initial stages of development, with a few satellites in geostationary orbits and, in the near future, with satellites in low Earth orbits. Those communications were currently oriented to fulfil the demand coming from mobile users (e.g. transport fleets), from difficult access locations (e.g. offshore oil rigs, mines), from rural communities and from emergency warning and disaster relief operations.

71. Although there was a growing interest in mobile communications, their development would depend on the evolution of important factors, such as technological progress, the availability of orbital positions (for geostationary satellites), spectral bandwidths, costs and performance to satisfy a wide range of applications and the capability to provide truly global services.

72. In spite of the impressive growth of global networks such as the Internet, most applications for global use had still not been developed. Projects were under way to make new systems available, such as the Global Information Infrastructure and Project G7. For instance, Project G7 considered applications in such areas as education, libraries, museums, natural resource and environmental administration, emergency situations, health services, government use, maritime transport and commercial transactions for small enterprises. For the development of many of those applications, it would be necessary to develop generic, value-added public services at the national and global levels.

73. For some countries the use of fixed satellite communication services, such as those provided by INTELSAT, might be the choice. Through the use of such services, countries could reduce costs and the risks associated with designing, launching and operating their own satellite systems. Other countries might find it cost-effective to combine the use of their national systems with well-established systems such as those operated by INTELSAT. Such an approach would provide users with access to state-of-the-art technology and to technical advice from the organization.

C. Satellite-based technology for sustainable development

74. It was stated that when natural hazards impacted on human communities or destroyed property, they were considered disasters. Not all natural hazards were disasters; fires, floods, earthquakes and drought all existed as part of natural cycles. Thus, a disaster occurred when an extreme event coincided with a vulnerable situation, surpassing society's ability to manage the consequences. In addition to their direct social and local economic consequences, natural disasters affected the macroeconomic standing of countries, increasing debt, reducing foreign income due to loss of exports and reducing overall production outputs. Those impacts had long-term effects on the economic health of the countries concerned.

75. Developing countries had few surveillance, early warning and disaster response programmes and, when confronted with catastrophic events, had to make decisions in a situation of shock, using outdated or incomplete communication and transportation systems and not having the benefit of an adequate information base. That was what made natural hazard management a development issue. Sustainable development thus reduced the population at risk and enabled a country to take adequate precautionary measures and to reduce the impact when precautionary measures were not sufficient.

76. Since 1960, hurricanes, floods, droughts, desertification and landslides in Latin America and the Caribbean had killed over 200,000 people, disrupted the lives of some 100 million others and caused over US$ 50 billion in property damage. Volcanic eruptions and earthquakes had taken the highest toll in terms of human lives and their financial consequences could be of the same order of magnitude. Drought had threatened the economic survival of the largest number of people and the economic losses due to floods rivalled those of earthquakes.

77. Drought and desertification were becoming a major source of alarm in Latin America, particularly along the Pacific coast of Chile and Peru, with milder but advancing traces in the coast of Ecuador. Very severe desert conditions were present in La Pampa in Argentina and in Chihuahua in Mexico. Severe desertification was evident in several provinces in Argentina, Bolivia, Chile, Mexico and Peru. Those symptoms could usually be attributed to some combination of exploitative land management and natural climate processes.

78. Salinization, frequently associated with desertification, was most often a result of uncontrolled and unwise irrigation resulting from lack of adequate water management policies and the prevalence of farming techniques inappropriate to the conditions of highly stressed soils. Remote sensing data and the use of geographical information systems had been successfully used in a sustainable development project in Valle de Tulum, Argentina, where natural

terrain conditions and agricultural practices had resulted in significant salinization of large areas and consequently in lower productivity of the valley.

79. Each year, several hurricanes struck the Caribbean, sometimes causing damage amounting to billions of United States dollars (e.g. Hurricane Gilbert in 1988 and Hurricane Hugo in 1989). Countries that had sustained the greatest damage, in terms of the number of people affected, included Cuba, the Dominican Republic, Haiti and Jamaica. Mexico normally experienced numerous hurricanes in the Yucatán peninsula. In Central America hurricanes had caused not only human suffering, but also severe damage measured in economic terms; Honduras and Nicaragua had been among the worst affected countries.

80. Space-based technology could help risk assessment concerning natural hazards by providing information to support the following tasks: (a) determination of the study area; (b) identification of natural hazards in the project area; (c) identification of population and structures at risk, and definition of their characteristics (size, location) and factors affecting their susceptibility to specific risks; and (d) identification and technical analysis of alternative mitigation measures.

81. Fixed and mobile communications satellites could provide the necessary means for disaster early warning systems. Through the use of portable antennas or mobile communication units, the capability existed to restore in just a few hours vital communications connecting the area affected by a disaster to relief headquarters and to the outside world.

82. Remote sensing techniques were particularly useful in the identification of areas subject to high natural hazard risks. This was because almost all geologic, hydrologic and atmospheric phenomena that created hazardous situations were recurrent events that left behind some evidence of their occurrence, allowing an observer to trace their origin, process and impact.

83. Earthquakes presented a peculiarly difficult subject for risk assessment, as the frequency of their occurrence might be in cycles of decades or centuries, rendering remotely sensed historical observations irrelevant. However, in areas with a history of earthquake activity, faults associated with seismic activity could be identified using satellite imagery. Radar imagery was an ideal data source for that purpose. The availability of satellite radar data would reduce the cost of studying large areas or covering specific events compared with the cost of doing it by conventional means.

Early warning of impending disasters

84. It was stated that results of risk analyses to detect an area's vulnerability to a natural disaster provided valuable information to the decision maker. Probability analysis followed to approximate a level of certainty that would warrant advising local authorities about the likelihood of an impending disaster. Perhaps the most important step in that phase was the translation of collected information into a format that could be easily understood by the decision maker. Satellite images were capable of providing a synoptic view of the problem and were particularly useful for that purpose.

Mitigation activities

85. It was stated that, among global environmental problems, natural hazards presented the most manageable of situations as the risks were most readily identified, effective mitigation measures were available and the benefits of reducing vulnerability more often than not outweighed the costs of prevention. The impact of natural hazards could be reduced by favouring non-intensive uses in high-risk areas.

Monitoring activities

86. It was stated that the objectives of an emergency monitoring system were: (a) to provide national protection agencies and relevant research institutions with information to support strategic and emergency decisions; (b) to re-establish the telecommunications and environmental data collection systems when an event had occurred in order to coordinate the local relief operations from the coordinating centre and to collect real-time environmental data; and (c) to assess real-time and a posteriori damages, data that would be useful for understanding the phenomenon and its consequences.

87. The monitoring of natural hazards was particularly useful where long-term processes were involved. Remotely sensed data had proved extremely useful in such cases, since repeated readings of surface changes, ground coverage and other factors could be made available by satellite imagery.

The role of national and international institutions

88. It was stated that pure scientific, applied and experimental research relevant to natural hazard management was required. As such research involved a large part of the principal fields covered in earth sciences and social research, the need was opening up niches for many actors in that area. However, funding for all forms of research was encountering great problems, particularly in developing countries, where other priorities seemed more urgent to decision makers. More recently, the private sector (industries, special interest groups) had entered the scene, providing services that constituted either input to or processed output for research endeavours. The possible relationships needed to be examined as those groups had the potential to become major contributors in that area.

89. Beyond research needs, disasters caused by natural hazards generated a demand for significant additional amounts of capital influx to support countries in their efforts to restore services and structures and to ease human suffering. Prime contributors to covering those financial needs were governmental (bilateral) donors, non-governmental relief services and multilateral financial institutions.

90. Multilateral development agencies had financed and continued to finance natural hazard assessment and disaster relief efforts, but did so mostly as part of other investment or technical assistance operations. Consequently, figures depicting specific support in that area were not easily derived from financial statistics. The World Bank had approved operations of environmental content (environmental institution-building, environmental management and pollution control, and natural resource management) for a total of US$ 5.10 billion in a four-year period (1989-1993), of which US$ 1.234 billion had been earmarked for Latin America and the Caribbean. The Inter-American Development Bank had allocated a total of US$ 4.842 billion to the region also for a four-year period (1990-1994). Both institutions were required to analyse natural hazard prevention and mitigation opportunities as part of project preparation.

V. CONCLUSION

91. The peculiar circumstances that surround developing countries are such that satellite communications and remote sensing can be of greatest help in most areas of sustainable development, although the acquisition of highly developed technology is considered a luxury item. To change that situation, efforts to convince high-level decision makers of the usefulness of space technology need to be intensified.

Notes

[1]See *Report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 9-21 August 1982* (A/CONF.101/10 and Corr.1 and 2), para. 430.

[2]*Official Records of the General Assembly, Forty-ninth Session, Supplement No. 20* (A/49/20), para. 37.

[3] *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

PROGRAMME OF THE CONFERENCE

Date/Time	*Subject*	*Speaker*
Monday, 30 October 1995		
0900-0930	Registration	
0930-1000	Opening ceremony	
	S. Camacho (Office for Outer Space Affairs of the United Nations Secretariat)	
	V. Hood (ESA)	
	R. Alvarez (Instituto de Geografía, Universidad Nacional Autónoma de México (IG/UNAM))	
	M. Bonilla (Consejo Nacional de Ciencia y Tecnología)	
	E. Méndez (Instituto Mexicano de Comunicaciones)	
1000-1040	**Keynote address**	
	Sustainable development - key support from space systems in achieving it	M. Orrico (International Astronautical Federation)
Session A: Developing an infrastructure to utilize space technology; E. Méndez (Instituto Mexicano de Comunicaciones), Chairman		
1100-1140	Establishing a national policy and infrastructure to utilize space technology for development	A. Quezada (Chile)
1140-1220	Sustainable development - its meaning for the United Nations	S. Camacho (Office for Outer Space Affairs)
Session B: Addressing major quality of life needs - support from satellite systems; J. Roch (Instituto Mexicano de Comunicaciones), Chairman		
1400-1440	ERS and ENVISAT - programmes to support sustainable development and environmental monitoring	M. Fea (ESA)
1440-1520	Establishing a base line for sustainable development projects in the south-east of Mexico	R. Alvarez (IG/UNAM)
1540-1620	Use of fixed and mobile space communications in stimulating the economy	R. Estrada and M. Gutiérrez (Instituto Mexicano de Comunicaciones)
1620-1730	Discussion	

Date/Time	*Subject*	*Speaker*
Tuesday, 31 October 1995		
Session C: Practical use of Earth observation data for sustainable development; H. Harszenbaum (CAERCEM), Chairman		
0900-0940	Current and future ESA programme opportunities in research and operational activities	M. Fea (ESA)
0940-1020	Mapping and monitoring natural resources and environmental degradation	S. Moreau (Asociación Boliviana de Teledetección para el Medio Ambiente)
Session D: Establishing an infrastructure for sustainable development - ways and resources; H. Karszenbaum (CAERCEM), Chairman		
1040-1120	Planning and management of sustainable development - a case study in the Valle de Tulum	G. Salinas (Universidad Nacional de San Juan, Argentina)
1120-1200	A sustainable development project for the south of Venezuela	C. Meneses (Ministerio del Medio Ambiente y Recursos Naturales Renovables)
1200-1230	Discussion	
Section E: Establishing an infrastructure for sustainable development - ways and resources; M. Farías (Universidad Católica), Chairman		
1400-1440	Integrating and conducting inter-institutional projects having a space technology component	C. Elizondo (Instituto Geográfico Nacional)
1440-1530	Brazil's space plan - ongoing projects and possibilities for bilateral and multilateral cooperation	G. de la Penha (Agencia Espacial Brasileira
1540-1730	Discussion	
Wednesday, 1 November 1995		
Session F: Communication needs and alternatives to meet them; E. Staffa (Inmarsat), Chairman		
0900-0940	Radio communication network in the health system for the rural areas	L. Validum (Guyana)
0940-1020	The role of satellite systems in meeting the demand for international and domestic communications	D. Martos (INTELSAT)
1040-1120	Satellite communication needs in the Latin American and Caribbean region	J. Zavattiero (ITU)
1120-1200	The Solidaridad system of satellites - possibilities for regional communications	E. Cervantes (Telecomm)
1200-1230	Discussion	
Session G: Satellite communications to support education, health and disaster management; M. Gutierrez (Instituto Mexicano de Comunicaciones), Chairman		

Date/Time	*Subject*	*Speaker*
1400-1440	Space technologies for natural disaster management	H. Landazuri (IDB) and D. Piaggesi (Nuova Telespazio)
1440-1520	The role of space communications in disaster warning, prevention and mitigation	E. Staffa (Inmarsat)
1540-1630	Discussion	

Thursday, 2 November 1995

Session H: Monitoring the environment - possibilities for global and regional cooperation; C. Elizondo (Instituto Geográfico Nacional), Chairman

0900-0940	Global mapping of stable VNIR sources (cities, towns, gas flares) and fires	C. Elvidge (NOAA)
0940-1020	Early results of global monitoring of biomass burning	C. Elvidge (NOAA)
1040-1120	A regional centre for space science and technology education in Latin America and the Caribbean	S. Camacho (Office for Outer Space Affairs)
1120-1200	Development of operational applications - Remote Sensing and GIS Programme	M. Farias and G. Ghio (Universidad Católica de Chile)
1200-1230	Discussion	
1400-1700	**Working group discussion on earth observation and on space communications; M. Fea (ESA) and S. Camacho (Office for Outer Space Affairs), Chairmen** Parallel discussions and recommendations on: (a) Identifying appropriate technologies, techniques and data to support project planning and execution; (b) Developing an "awareness" among decision makers of the cost effectiveness of using space technology; (c) Establishing follow-up networks.	

Date/Time	*Subject*	*Speaker*
Friday, 3 November 1995		
Session H: Acquiring experience in proven applications of SAR data		
0900-0940	Results and experiences from the SAREX and GlobeSAR campaigns	F. Campbell (Canada Centre for Remote Sensing)
0940-1020	Potential of RADARSAT data in Earth observation applications and project development initiatives in Latin America	R. Duncan and P. Welgan (RADARSAT International of Canada)
1040-1230	Working group discussion	
	Discussion and recommendations regarding national or international cooperative actions in:	
	(a) Establishing follow-up networks;	
	(b) Mechanisms for exchange of information;	
	(c) Education in space science and technology;	
	(d) Participation in regional and global programmes.	
1230-1300	Summary of the working group discussions	
1300-	Closing ceremony	