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REPORT ON THE UNITED NATIONS/INTERNATIONAL ASTRONAUTICAL FEDERATION WORKSHOP ON EDUCATION AND AWARENESS: SPACE TECHNOLOGY AND APPLICATIONS IN THE DEVELOPING WORLD

(Beijing, 3-6 October 1996)

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INTRODUCTION

A. Background and objectives

1. In its resolution 37/90 of 10 December 1982, the General Assembly endorsed the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space that the United Nations Programme on Space Applications should promote the growth of indigenous nuclei and an autonomous technological base in space technology for developing countries. In June 1995, the Committee

on the Peaceful Uses of Outer Space (COPUOS) at its thirty-eighth session endorsed the United Nations Programme on Space Applications for 1996 as recommended by the Scientific and Technical Subcommittee at its thirty-second session. Subsequently, in resolution 50/27 of 6 December 1995, the General Assembly endorsed the activities of the Programme on Space Applications for 1996.

2. The present report contains a summary of the United Nations/International Astronautical Federation Workshop on "Education and Awareness: Space Technology and Applications in the Developing World". The Workshop was organized as part of the 1996 activities of the Office for Outer Space Affairs under the United Nations Programme on Space Applications. The Workshop was the sixth in a series organized by the United Nations, and was held at Beijing in conjunction with the forty-seventh Congress of the International Astronautical Federation (IAF). Previous symposia and workshops in this series were held in Austria, Canada, Israel, Norway and United States of America.

3. The main objective of the Workshop was to increase the awareness and the understanding of policy and decision makers and the general public in developing countries of the benefits of applications of space technology for national development. The Workshop was also intended to increase the awareness and understanding of the public in developing countries of the benefits to be derived by appropriate applications of space technology.

4. Participants were provided with information on the possibilities offered by current space technologies, as a basis for discussing ways in which the participants could use those technologies in ongoing or planned programmes and projects. The Workshop also considered how the mass media might be encouraged to promote applications of space technology.

5. Implementation of national and transnational space projects were introduced during the Workshop. Presentations and discussions during the meeting addressed specific issues related to the overall theme of the Workshop, including: the value of space technology for sustainable development and environmental monitoring; educational aspects of space applications of space technology; and space systems in support of terrestrial infrastructures.

6. The present report, covering the background and the objectives of the Workshop, as well as the presentations, discussions, observations and conclusions made by the participants, has been prepared for consideration by the Committee on the Peaceful Uses of Outer Space at its fortieth session and by the Scientific and Technical Subcommittee at its thirty-fourth session. Participants will report to the appropriate authorities in their own countries.

B. Participants

7. The United Nations invited developing countries to nominate candidates to participate in the Workshop. Selected participants were required to have university degrees in remote sensing, communications, engineering, physics, biological or medical sciences or other fields related to the themes of the Workshop. Participants should have been working in programmes, projects or enterprises in which space technology could be utilized. Policy makers, at a decision-making level from both national and international entities, were also invited.

8. Funds allocated by the United Nations, IAF, the European Space Agency (ESA) and the Government of China for the organization of the Workshop were used to cover the international air travel and per diem expenses of 31 participants from developing countries for the period of the Workshop and the IAF Congress. For some of the selected participants from developing countries, registration for the Congress was also covered.

9. A total of 93 participants from the following Member States and international organizations attended the Workshop: Bangladesh, Brazil, Cambodia, China, Egypt, Fiji, India, Indonesia, Kenya, Lao People's Democratic Republic, Malaysia, Nigeria, Pakistan, Philippines, Sri Lanka, Syrian Arab Republic, Tunisia and United Republic of Tanzania; Office for Outer Space Affairs, the International Telecommunication Union (ITU) and the World Meteorological Organization (WMO); ESA, the Earth Observation Satellite Company (EOSAT), IAF, the International Mobile Satellite Organization (Inmarsat), the International Telecommunications Satellite Organization (INTELSAT), the International Space University (ISU) and the International Institute for Aerospace Survey and Earth Sciences (ITC). The participation of experts from Austria, Japan, Netherlands, United Kingdom of Great Britain and Northern Ireland and United States also contributed to the success of the Workshop.

I. PRESENTATIONS AND DISCUSSIONS DURING THE WORKSHOP

A. General themes

10. Well-established models of space applications were presented during the course of the Workshop with the aim of developing general guidelines on how developing countries can successfully use space technologies, including remote sensing and space communications systems, for environmental preservation and economic and social development. A representative from each of the developing countries presented outlines of its national programme, followed by three panel discussions and an open exchange of views. The participants interacted vigorously, providing information, comments, questions, recommendations and suggestions.

11. National and transnational space projects and programmes were discussed during the meeting, and future possibilities were suggested for increased scientific and technical cooperation between industrialized and developing countries, as well as among developing countries themselves.

B. Sustainable development

12. Major food resources come from rural or remote areas, and the infrastructure needed to develop and manage both agriculture and fisheries normally has been tedious and expensive. Recent developments using space technology have shown that expenditure on infrastructure can be significantly reduced and major efficiencies obtained. Begun in 1992 and currently operational, the African Real Time Environmental Monitoring Information System (ARTEMIS) is a demonstration of what can be achieved. The use of space technology yields information that can assist in monitoring cereal production and providing early warning of trends in food availability, particularly in drought-prone areas. Furthermore, satellite data provide information on cold cloud duration and the state of vegetation.

13. Tropical forests are an important part of the Earth's ecosystem and a valuable resource for many developing countries. These forests are in some of the most remote locations on Earth, and in most cases are inaccessible or difficult to survey using conventional techniques. However, ongoing studies using data from a thematic mapper have shown that a forest register can be produced that contains a basin-by-basin inventory of forest estates categorized by forest types. Such a forest register has the advantage of providing developing countries with an infrastructure for environmentally sustainable forest management plans.

14. In Sri Lanka, one of the main areas of concern is forest cover. Land use mapping has been performed on a scale of 1:100,000 using aerial photography and satellite data, mainly provided by the Indian remote sensing satellite (IRS), the United States Landsat Thematic Mapper and the French Satellite pour l'observation de la Terre (SPOT) (Earth observation satellite). A recently updated forest cover map of Sri Lanka shows that the territory covered by forest has decreased dramatically in recent decades, indicating the need to initiate forest preservation and afforestation strategies.

15. The infrastructure needed to understand and manage the natural water resources of a country using conventional technologies is both expensive and complex. The growing use of space-based technologies in observing and mapping river and stream systems now provides a mechanism that is both within the state of science and relatively inexpensive. Studies and demonstration projects have already identified areas where savings could reduce costs by about two thirds.

16. Through both visible and infrared imagery, it is now possible to make reasonable estimates of the precipitation that has fallen in a particular river basin, and thus to estimate the run-off and change in the river flow. Similarly, new satellite technology, particularly using microwaves, can now provide gross indications of soil moisture at the surface. The ability to measure and monitor the availability of water is perhaps one of the most important contributions to the infrastructure needed to manage those natural resources that could eventually become seriously depleted in the near- and long-term future.

17. In many developing countries, space technology as a new tool for development will undergo a long process from the stages of research and manufacturing to commercial utilization. A systematic application of space technology in support of national development needs strong government support. In China, an industrializing country, efforts are being made to enlarge the scope of space applications for sustainable development. For example, the Harbin Institute of Technology provides training facilities to educate young scientists in using space technology in support of social and economic development.

18. The Indonesian National Institute of Aeronautics and Space (LAPAN) has been entrusted by the Government to operate remote sensing ground stations to acquire satellite data mainly from the European Remote Sensing satellite (ERS), the Japanese Earth Resources Satellite (JERS), the Land Remote Sensing Satellite (LANDSAT) and SPOT, thereby assisting in the management of natural resources. Information based on such satellite data, such as forest inventory, mangrove inventory, paddy and crop assessment, drought and flood conditions and forest fire locations, is communicated to the responsible agencies for further processing and planning. Several coordinating bodies have been set up in the recent past to cooperate with LAPAN, for example, the National Coordinating Agency for Disaster Management.

19. In Brazil, the national space programme is managed by the Brazilian Space Agency. Its role is to coordinate the actions undertaken by various ministries in accordance with Brazilian space policy. The main objective of that policy is to enhance the capability of space technology to accelerate national development and to monitor the environment.

20. Several ecosystems in Brazil need to be protected, such as the Amazon rainforest and the Atlantic forest. The Brazilian space policy supports development and environmental preservation through satellite systems, providing the following services: data collecting and processing; remote sensing and imagery processing; and extending the national communications infrastructure.

21. The Indian space programme has been designed to accelerate national development and to improve the human condition. Twenty-five State remote sensing applications centres are coordinating and conducting national programmes in support of natural resource management and sustainable development. Remote sensing satellites and Geographic Information Systems (GIS) are increasingly being used for mapping natural resources and hazard management. Decision makers are frequently provided with socio-economic data and environmental studies performed at those centres, to serve as a basis for policy- and decision-making and planning.

22. As a successful example of space applications at the village level in India, cost-effective remote sensing techniques have been applied to identify land and water resources in order to map the basic integrated land and water resource units in the Anantapur district, located in the south-west of the State of Andhra Pradesh. Detailed mapping of natural resources on a scale of 1:50,000 has been undertaken, using data from the Information Retrieval Service remote sensing satellite of India, known as IRS-1A. The various scientific

recommendations made on the basis of analyses of remote sensing data have been validated in the field by several rural exercises.

23. On the basis of the encouraging results of the pilot study carried out in the Anantapur district, a nationwide project entitled "Integrated Mission for Sustainable Development" was launched in 172 districts spread over the whole country. Those districts, frequently affected by droughts and floods and covering 45 per cent of the geographical area of India, were being extensively surveyed from outer space through the use of satellite remote sensing systems.

24. In the Philippines, ERS-1 synthetic aperture radar (SAR) data are used to provide information on active lahar. The main physical parameters that have to be considered are surface roughness, image texture and morphology. While at this stage it seems difficult to accurately map lahar boundaries, radar imagery, including ERS-1 SAR data, will play a major role in monitoring changes because of its all-weather sensing capability. The radar data will be particularly useful for monitoring the Mount Pinatubo area during the typhoon season through cloud cover, which adversely affects optical remote sensing sensors. Radar imaging will be essential for providing accurate and timely information on lahar-affected areas to be used for disaster mitigation strategies such as early warning and evacuation plans.

25. Today, the vital role of meteorological services for sustainable development is well recognized. The operational network of satellites within the World Weather Watch Department of WMO provides near continuous observations of the Earth's atmosphere, lithosphere and hydrosphere. The current network includes six satellites in geostationary orbit and three in polar orbit. While this configuration provides considerable support to remote and rural areas, there are plans to increase the number of satellites and instruments available for use by developing countries.

C. Educational aspects of space applications

26. A movement in the United Kingdom to introduce space education into the educational programmes of young people has been, at least in the initial stages, teacher-driven rather than imposed by the Government. The impetus for its use occurred at the grass-roots level, with teachers and educators using space applications to support their teaching and to enhance the quality of learning of their pupils. A few motivated individuals have worked by example to win over their peers to an appreciation of the value of space data in enhancing the learning ability of pupils within the established curriculum.

27. The experience gained by providing remote support and training via personal conferencing can be harnessed to the advantage of developing countries. Expert trainers and advisers can be readily accessed on a daily basis if necessary, both to train key personnel and to provide information within the countries concerned. These newly trained individuals can then transmit knowledge or training to citizens within their own countries, while still having regular contact with their mentors wherever they might be geographically.

28. In the longer term, it should also be to the advantage of developing countries that young people in the developing world are better informed about their programmes and needs. By providing data on a global basis, space applications promote understanding and make it easier for teachers and educators in developing countries to include space studies in their educational programmes, thus promoting a wider understanding of world issues among future generations.

29. Moreover, the value of space technologies for supporting and sustaining rural life must not be underestimated. The challenge is to harness their potential so that rural populations can be maintained and strengthened, with the subsequent social and cultural benefits that accrue.

30. It is vital, therefore, that teachers and educators in both developed and developing countries should be encouraged to promote the usefulness of space technology so that maximum progress can be achieved according to the requirements of the end-user.

31. On the African continent, only a few countries are equipped with appropriate training and education facilities for space technologies. The results of a recent survey of training facilities reveal that more staff is trained abroad than within Africa. Furthermore, a close investigation shows that many space applications are just ad hoc projects without the prospect of being conducted on a sustainable basis.

32. African countries should provide for substantial investment in the education of specialists to apply space technology for national development, and especially for managing natural resources. In the future, it may be possible that a mechanism for space cooperation could be established in Africa both to coordinate the sharing of experience and to promote space activities in the continent.

33. Recognition of the potential of satellite-based tele-education and telemedicine in rural and remote areas of the world is increasing. Beginning with the Advanced Technology Satellite (ATS) experiments in the 1970s and the INTELSAT Project Share tests and demonstrations, it has become clear that this is one of the few approaches that has the scope to make a true planetary impact on problems of health care and education in rural areas.

34. In India, experiments were carried out with ATS-6 in the so-called SITE experiments. This led to the definition, manufacture and launch of the Indian national satellites which could broadcast educational programming to low-cost terminals in rural India. That programme has been implemented using community antenna television broadcasts, and now provides educational and health training courses to thousands of villages in remote areas of India.

35. In Indonesia, the Palapa satellite system was deployed to link the more than 18,000 islands of the country. The primary goal of the system was to provide modern and reliable communications to a country whose geography represents a very special challenge. An important second goal was to provide rural tele-education services to underserved areas. A synergy was achieved by combining satellite services to commercial and industrial sites in rural areas where oil, timber or other resources were being exploited with services to rural educational and training sites.

36. In China, tele-education experiments were conducted under the INTELSAT Project Share. Half the programming was produced by the Ministry of Education and half by Central China TV. The Ministry of Post and Telecommunications implemented the space transmission systems. Today, the China Satellite Educational Television Project uses over 90,000 terminals, all manufactured in China. It reaches over three million students and is the largest satellite tele-education project in the world.

37. Impressive as the gains in tele-education and tele-health services have been, future progress will be even more so. The powerful tool of the INTERNET, which now links some 30,000 computer networks and over 40 million users worldwide, will continue to grow and expand. This network, which is supported by both satellite and fibre optic links, can support access to key educational and medical web sites, and allow instruction and medical consultation to be carried out by diverse methods such as e-mail or videoconferencing links.

38. Two design projects performed by students of ISU summer sessions held at Barcelona, Spain, in 1994 and at Vienna in 1996 - namely the Global Access to Tele-health and Education System and the Distant Operational Care Centre - should be able to give some key insights into the future of tele-education and tele-health services.

D. Improving infrastructures through space systems

39. Today, the infrastructure in remote and rural areas can be significantly improved through satellite remote sensing, particularly with respect to natural disaster warning and mitigation, management of water, forest and food resources, planning and operation of transport systems and other supporting activities relating to social and economic development.

40. The Indian Space Research Organization (ISRO) has already established basic facilities at its various centres and units for the effective utilization of space capabilities, particularly remote sensing applications, by adopting a user-friendly approach. ISRO has enlisted the user community in India, including individuals, private entities, national and regional organizations and institutions, to assist in its various programmes.

41. Space technology through the INTELSAT system has enabled many developing countries to establish, for the first time, high-quality independent communications links abroad. For large countries and those with severe terrain and climate obstacles, it has also been possible to establish domestic communications at reasonable cost through the INTELSAT system. A number of the countries concerned subsequently established their own domestic satellite systems.

42. Inmarsat is actively engaged in assisting users in China in solving their regional, educational and emergency communication needs. Such assistance has involved fleet management operations, supervisory control and data acquisition networks using Inmarsat mobile data, as well as emergency and disaster relief operations for the Ministry of Posts and Telecommunications. Within these emergency networks, there is a strong emphasis on ensuring a rapid response to emergency situations.

43. A major initiative for Inmarsat is to facilitate the economic development of rural and remote communications through the provision of effective communication facilities and services. Several pilot projects are in progress, including: the provision of Inmarsat phones to selected rural communities to accelerate local economic development; the development of systems for the transfer of funds directly to remote communities; and a rudimentary system to promote the exchange of agricultural supplies.

44. Satellites have thus proved their value to developing countries in the context of international long-distance communications. They have, more than any other technology, linked the countries of the world, and associated developing countries in that process.

45. The World Bank estimates that approximately 30 billion United States dollars are needed annually to meet the requirements for an appropriate telecommunications infrastructure in developing countries. Today, it is estimated that less than one tenth of that amount is available from traditional sources, including the contribution of developing countries themselves, bilateral aid, supplier credits, loans from the World Bank and regional development banks. The private sector should be approached even more to provide funds towards improving the communications infrastructure in developing countries.

46. ITU is engaged in a variety of activities intended to stimulate the development of telecommunications in rural and remote areas. These range from direct assistance in the implementation of projects to training, seminars and support for regulatory reform and for restructuring.

47. ITU is currently undertaking the SPACECOM Project in order to promote the widest application of space technology to the communication problems of developing countries. It is pursuing that project by forging partnerships between industry, satellite operators and Governments of developing countries. One of the elements of the SPACECOM Project is to encourage the use of space technology in applications such as telemedicine, tele-education and trade.

II. OBSERVATIONS AND CONCLUSION

48. As part of the national economy, the space industry should not be isolated. The space industry and other high-technology industries depend greatly on the overall scientific and technological standard and industrial strength of a country. In most cases, successful space programmes and projects require high initial investments. It is therefore necessary to convince policy and decision makers, particularly in developing countries, of the value of providing resources to space programmes in appropriate areas, pointing out successful examples of space applications within the country concerned or in other developing countries.

49. The United Nations has played a major role in promoting space cooperation between developing and developed countries through several of its regional space application programmes. Among others, the Regional Remote Sensing Programme, initiated in the 1980s for the Asian Pacific Region with the assistance of the United Nations Development Programme, has been an outstanding example of the promotion of regional cooperation in applying space technology through pilot projects, training courses and seminars. Following this success, a Regional Space Applications Programme (RESAP) has recently been established for the region of Asia and the Pacific, expanding space technology applications by including satellite communications, satellite meteorology and space science.

50. Existing cooperative entities in the region, such as RESAP, the Asian Association on Remote Sensing and the Expert Group on Remote Sensing of the Association of South-East Asian Nations, are powerful tools for initiating space projects jointly managed by developing and developed countries.

51. The Economic and Social Commission for Asia and the Pacific is currently developing a standard to facilitate the wider use of sharing of resource databases in the region of Asia and the Pacific. Participants reiterated that the exchange of data and information on a bilateral or regional basis is important for sharing experiences in preventing or mitigating transboundary and global problems such as environmental pollution and natural disasters.

52. The unique characteristics of space technology make it essential to have effective interaction between space experts and policy makers to ensure appropriate linkages with overall national programmes, as well as the continued support of the public at large. Such an approach also makes possible the implementation of space-based development plans, which should be one of the primary objectives of any national space policy.

53. Workshop participants recommended that before projects are defined, the needs of the user community should be more clearly established. Once the project is begun, ongoing evaluations should occur to ensure that these objectives remain on target. Furthermore, at the conclusion of the project, the institutions created to implement the plans should be evaluated.

54. In India, efforts have been made to follow an applications-driven approach and establish a strong interface with national policy makers. The strategy adopted by India was to demonstrate to the decision makers, with the total involvement of the user community, the efficiency of space systems designed to address development needs. The operational mechanisms established to permit such a dialogue have been widely acclaimed as highly successful initiatives.

55. One of the fundamental differences between developing and developed countries is in education. Developing countries would benefit from the use of space technology in this area, as science and education are usually the leading factors in development and national prosperity.

56. The most productive training is that targeted at local resource managers and policy and decision makers. Space technology in support of Earth observation and communications infrastructure needs to be considered a tool or technique that anybody could use. As such, training courses need to be highly practical, based on

local examples and facilities, with the emphasis on simplicity rather than complexity. However, in-depth education in the fundamental concepts of the technology should not be disregarded.

57. The most sustainable way to encourage the use of space technology is through educational curricula in local universities.

58. Evidence from many countries shows that universities are developing the important capability to provide a practical local introduction to Earth observation techniques. There is a need to concentrate on training university teachers to make the best use of materials available to them, for as wide a variety of local applications of Earth observation techniques as possible. This enhanced role for local universities appears to be promising - given its current successes in the areas of awareness-raising, training, education, research and even consultancy - and should be encouraged, since there is now a favourable policy environment for such initiatives.

59. It is particularly important that as many graduates as possible should be aware of the pace of environmental change and how to make use of straightforward Earth observation techniques for long-term improvement in environmental management. If remote sensing is to have an impact at community levels, then it is also important that schools should start the process of raising environmental awareness through introducing straightforward Earth observation techniques to their pupils.

60. Awareness-raising is absolutely vital, but can be counterproductive if it is not done sensitively. It is particularly important that senior decision makers in institutions should be aware of what can be done to meet their precise information needs in a cost-effective and timely manner, without the need for major monetary investments. Awareness-raising is best undertaken by specialists such as agricultural or water resource managers rather than by remote sensing specialists.

61. Participants stated that demonstration models of space technology applications should be introduced to the public, including inexpensive and simple-to-use meteorological satellite stations, television receive-only terminals, very small aperture terminals and CD-based personal computers for display and manipulation of remote sensing satellite imagery.