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United Nations/United States of America Third Regional Workshop on the Use and Applications of Global Navigation Satellite Systems

(Santiago, 1-5 April 2002)

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I. Introduction

A. Background and objectives

1. Global navigation satellite systems (GNSS), with their extremely high accuracy, global coverage, all-weather operation and usefulness at high velocities, are a new global utility that increasingly improve people's daily lives. Benefits of GNSS applications are growing in such areas as aviation, maritime and land transportation, mapping and surveying, agriculture, power and telecommunications networks, and disaster warning and emergency response. Particularly for developing countries, GNSS applications offer cost-effective solutions to pursuing economic growth without compromising the present and future need to preserve the environment, thus promoting sustainable development.

2. At the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), participating States stressed the social and economic benefits of GNSS. In order to help developing countries benefit from GNSS applications, the Office for Outer Space Affairs, within the United Nations Programme on Space Applications, proposed in a plan of action to implement the recommendations of UNISPACE III to organize a series of workshops or seminars focusing on capacity-building in the use of GNSS in various areas of application. The proposal was endorsed by the Committee on the Peaceful Uses of Outer Space, and the General Assembly, in its resolution 55/122 of 8 December 2000, paragraph 29, requested the Secretary-General to begin implementing the activities in the plan.

3. In 2001, the Office for Outer Space Affairs, within the framework of the United Nations Programme on Space Applications and with the sponsorship of the United States of America, began a series of regional workshops on the use and applications of GNSS. The first regional workshop was held in Kuala Lumpur in August 2001 for the benefit of countries in Asia and the Pacific. The second was held in Vienna in November 2001 for the benefit of countries in Central and Eastern Europe.

4. The present report concerns the third regional workshop, held in Santiago from 1 to 5 April for the benefit of countries in Latin America and the Caribbean. The Government of Chile hosted the workshop.

5. The workshop focused on issues of common concern and interest to the region, such as those addressed at the Third Space Conference of the Americas, held in Punta del Este, Uruguay, in 1996, and the Regional Preparatory Conference for UNISPACE III for Latin America and the Caribbean, held in Concepción, Chile, in 1998.

6. The objectives of the workshop were: (a) to bring the benefits of the availability and use of the GNSS signals to the awareness of decision makers and technical personnel from potential user institutions and service providers in the private sector, particularly those in developing countries in the region; and (b) to identify actions to be taken and partnerships to be established by potential users in the region to integrate the use of GNSS signals in practical applications to protect the environment and to promote sustainable development. The short- to medium-term results of the workshop would be the launch of pilot and demonstration

projects by Governments, research institutions and the industry that would benefit from the introduction of the technology. The long-term result would be the expansion of the user base of GNSS technologies.

B. Programme

7. At the opening of the workshop, keynote addresses were delivered by N. Hadad, President of the Chilean Space Agency; P. S. Goldberg, Deputy Chief of Mission of the Embassy of the United States of America to Chile; Raimundo González A., Permanent Representative of Chile to the United Nations (Vienna) and Chairman of the Committee on the Peaceful Uses of Outer Space; M. E. De Vel of the European Space Agency (ESA); P. Jankowitsch, Chairman of the Supervisory Board, Austrian Space Agency; and the Expert on Space Applications of the Office for Outer Space Affairs. The workshop included the following seven technical sessions: (a) existing and future GNSS systems and their applications; (b) use and applications of GNSS in civil aviation; (c) GNSS applications to support disaster management; (d) GNSS applications for agriculture and natural resources management; (e) GNSS applications for geodesy, surveying and mapping; (f) GNSS and precision timing: applications to telecommunications and Earth sciences; and (g) expanding the use of GNSS in protecting the environment and managing natural resources. In order to assist in developing recommendations, the workshop established five working groups on the following issues: (a) civil aviation; (b) disaster management; (c) agriculture; (d) high-accuracy applications: geodesy and Earth sciences; and (e) education and training. In total, 34 presentations were made.

8. The workshop was held in conjunction with the International Air and Space Fair, known as FIDAE, which was held concurrently. The programme of the workshop included a visit to the exhibit booth of the Global Positioning System (GPS) of the United States, to take advantage of the availability of a team of GPS experts and to allow for interactions between the participants of the workshop and the experts. In addition to the scheduled visit on the first day, participants of the workshop had opportunities to visit the GPS exhibit booth throughout the duration of the workshop. The participants were also invited to the opening of FIDAE.

9. During the workshop, the preparatory conference for the Fourth Space Conference of the Americas was also held at the site of FIDAE. The Executive Secretary of the Conference addressed the workshop during a closing session and informed the participants that the Conference would consider the issue of the use and applications of GNSS, taking into account the results of the workshop.

10. The programme was developed by the Office for Outer Space Affairs and the United States Department of State in cooperation with the Ministry of Foreign Affairs of Chile and the Chilean Space Agency.

C. Attendance

11. Participants at the workshop came from the following countries: Argentina, Austria, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, France, Germany, Guatemala, Haiti, Mexico, Panama, Peru, Russian Federation, Trinidad

and Tobago, United States and Uruguay. The Economic Commission for Latin America and the Caribbean, the European Commission, ESA and the Office for Outer Space Affairs of the Secretariat were also represented.

12. Funds allocated by the United States were used to defray the costs of air travel and daily subsistence allowance of 29 participants from 12 countries and staff of the Office for Outer Space Affairs, as well as travel and salaries of a consultant. ESA defrayed the cost of air travel and daily subsistence allowance of seven participants from five countries. The Government of Chile covered the cost of local organization, including the use of the conference room and facilities, interpretation services in English and Spanish, local transportation for the participants and salaries of technicians.

II. Observations and recommendations

13. Electronic versions of the presentations submitted to the Office for Outer Space Affairs are available on the web site of the Office (http://www.oosa.unvienna.org/SAP/act2002/gnss1/presentations/index.html).

14. The observations and recommendations of the workshop, which are based on the reports submitted by the chairpersons of the working groups, are summarized below.

A. Existing and future GNSS systems and their applications

Observations

15. Satellite navigation builds upon terrestrial-based radio navigation that has been used by aviation and shipping over the past 100 years. Navigation satellites broadcast signals that are used by a receiver to determine exactly the receiver's position, velocity and precise time worldwide. User receivers of satellite navigation signals measure the distance of the receiver equipment to the satellite using a technique called "passive ranging". In this technique, the distance to each satellite is derived from the measurement of the time the navigation signal needs to travel from the satellite to the receiver. The three-dimensional position of the receiver can be calculated if signals from at least three satellites are available. The signal from a fourth satellite is used to avoid the need for a precise atomic clock at the receiver.

16. Standard GNSS signal processing provides around 100-metre accuracy at the location of the receiver, while precision signal processing provides around 20-metre accuracy. If, in addition to the signals from the satellites, a user receiver also receives the signal of a ground-based reference station, the accuracy at the location of the user receiver is around one metre. Reference stations make differential GNSS (DGNSS) services possible.

17. The session on the existing and future GNSS systems and their applications addressed the status and development of GPS, the Global Navigation Satellite Systems (GLONASS) and Galileo, as well as GNSS activities in the Eastern European region, including those relating to differential system development.

18. The workshop noted that GPS, a dual-use system implemented by the United States, was fully operational and provided an open, civil navigation service free of direct user fees. The space segment of GPS consisted of 28 operating satellites, in order to ensure that there were 24 operating satellites on 6 orbital planes, with 4 operating satellites per plane, at any given time. The workshop was briefed on civil benefits of GPS modernization and noted that the setting of selective availability to zero was a first step in that process. Efforts were being made to receive user feedback through various channels and methods. The policy of the United States on GPS had been consistent, even during and after events such as the Gulf War and the terrorist attacks of 11 September 2001. Outreach activities and international cooperation, such as those with the Russian Federation, Europe and Japan, remained an important part of the policy of the United States. The principles for cooperation included no direct user fees, open signal structure, open market-driven environment and protection of the current radio-navigation spectrum.

19. The workshop was briefed on the status of GLONASS, a dual-use system implemented by the Russian Federation. A federal programme had been approved by the Government of the Russian Federation in August 2001 to re-establish the GLONASS constellation. The constellation was to consist of 24 operating satellites on 3 orbital planes, with 8 operating satellites per plane. At the time of the workshop, there were 7 operating satellites, and 3 more satellites were being planned for launch in November 2002. The main programme goals included the guaranteed provision of service for international users. The main programme tasks included the strengthening of international cooperation, development of equipment for users that would be competitive on the international market, creation of a new geodesy network and development of scientific and technological bases for further satellite navigation development.

20. The workshop was briefed on an initiative by European countries known as Galileo, a civilian programme involving the European Commission, which was responsible for policy development, and ESA, which was responsible for the technical development programme. Galileo was planned to be operational from the year 2008. The motivation of the European initiative included achieving sovereignty, autonomy and a guarantee of service for European countries; benefits to industry; certifiable safety of life applications; and availability of complementary and backup systems to GPS and GLONASS. Galileo would provide a variety of global services free of charge to all users, while value-added services would be provided at a cost. It was reported that the decision had been made on 25 March 2002 to proceed with the funding of the project through the development phase. The workshop noted that Europe was implementing the European Geostationary Navigation Overlay Service (EGNOS) System, which was an integral part of the three current interregional systems to enhance the capability of GPS and that EGNOS was planned to be operational in 2004.

21. The workshop was briefed on the ongoing negotiations among the United States, the European Union and the Russian Federation to achieve system interoperability and compatibility between Galileo and GPS and Galileo and GLONASS, respectively.

22. The workshop was briefed on the current status and future plans for GPS augmentation systems and their benefits. Augmentations had been developed to reinforce the integrity, accuracy, continuity and availability of GPS signals, in order

to further improve safety of flight for all operations. While the Aicraft-Based Augmentation System (ABAS) was the principal augmentation to GPS today, several other augmentations to GPS were under development. Examples of satellite-based augmentation systems (SBAS) included the wide area augmentation system (WAAS) of the United States, EGNOS of Europe, and the multifunction satellite augmentation system (MSAS) of Japan. Examples of GBAS included the local area augmentation system (LAAS) of the United States and a ground-based regional augmentation system (GRAS) of Australia. Differential GPS (DGPS) was originally designed by the United States Coast Guard for maritime applications, but its benefits expanded to users near coastal and inland waterways. The workshop noted that DGPS and national differential GPS (NDGPS), which was the extension of DGPS to cover the interior of the country that otherwise was out of range of the DGPS reference stations, were one operating system covering the United States coast to coast.

23. The workshop noted the effects of the GPS modernization on augmentation systems. The workshop also noted that the need for GNSS augmentations would still exist for critical applications.

24. The workshop noted that the radio-navigation satellite system (RNSS) allocations in the 1164-1300 MHz band were shared with allocations for other ground-based systems. Owing to those shared allocations, the World Radio Communication Conference of the International Telecommunication Union (ITU) held in 2000 had adopted resolutions to limit the total aggregate broadcast energy of all GNSS in those bands using a technique known as a power flux density limit (PFD). The workshop further noted the possibility that radar and other ground-based systems would interfere with GNSS signals.

25. The workshop noted that it would be difficult for a user in a developing country to find experts and seek their advice. A readily available source of expert technical information would significantly assist potential GNSS users in solving their application-specific problems.

26. The workshop also noted that, in order to achieve the maximum benefit from GNSS applications, Governments of developing countries should play a role in ensuring that their users were aware of and received an adequate level of GNSS service.

Recommendations

27. The workshop recommended that efforts should continue to promote the use of GNSS. In that regard, the workshop noted the importance of the ongoing discussions in ITU concerning frequency bands with shared allocations. It was recommended that all GNSS users request their respective government officials to support the protection of the spectrum of GNSS at the 2003 World Radiocommunication Conference and to propose amendments to resolutions that encroached on the GNSS spectrum.

28. The workshop noted the difficulty encountered particularly in developing countries in finding experts in the use and applications of GNSS and in receiving technical advice. It was recommended that a comprehensive list of GNSS applications be developed and that the list be made available online by the United Nations. Such a list should also include technical experts who would be willing to

respond to enquiries from individuals from developing countries and information on contacting them.

29. The workshop noted that, while applications of GNSS and their benefits were increasing, government officials in developing countries were not necessarily aware of the benefits of GNSS. Government officials in developing countries should, therefore, be provided with appropriate tools to identify the benefits provided through GNSS applications.

B. Use and applications of GNSS in civil aviation

Observations

30. The workshop noted that the use of GNSS in aviation would lead to greater demands on the quality of the GNSS signal and its use in order to meet air safety requirements. In the Americas, the development of such systems was important in directly fostering the development of the air transportation sector. The workshop noted that such development would also promote developing countries' socio-economic development. The opportunity of using air navigation systems with worldwide coverage led to increasing interest among countries of the region in playing an active role in the development and implementation phases.

31. The workshop noted the absence of structured training programmes at the regional level that would enable participants to gain knowledge of GNSS and to acquire the skills and expertise necessary to guarantee the provision of air navigation service.

32. While general training courses proliferated in various countries, there was, except in isolated cases, no advance training at various degrees of specialization. Insufficient funding presented a main obstacle in carrying out specialized training programmes.

33. The workshop noted that, because research activities in the field of GNSS tended to be isolated, there was a duplication of efforts across the region.

34. The workshop also noted the difficulty in carrying out bilateral or multilateral technical cooperation programmes owing to, among other things, the absence of a database on ongoing or planned technical cooperation programmes for the region that identified areas of work. The limited availability of human and financial resources was another obstacle. There was also a lack of a clear link between GNSS activities and socio-economic development for the region. The workshop also noted the need for commitment on the part of Governments, international organizations and industry to carry out cooperation programmes with the aim of technology transfer.

35. The workshop noted the absence of national programmes to disseminate information on the implementation of GNSS in general and on the use of GNSS in various national economic sectors. There was a need for analysis and assessment at the regional level on the use of GNSS under various technical and operational scenarios. The workshop also noted that technical, operational and economic feasibility studies on the use of GNSS in air navigation in the region would be

required for various operators in the air transportation sector, including those in general aviation.

Recommendations

36. The workshop recommended that the countries and international organizations that were system providers of GNSS should provide technical and financial support to countries in the region to develop and implement specialized training programmes. It was also recommended that industry should be involved in providing the necessary facilities for training and research activities, including equipment, hardware and software simulators and specialized reference materials.

37. States and organizations that were involved in the development of GNSS should enable the countries in the region, through technical cooperation programmes, to acquire the capacity to directly take part in GNSS development activities, taking into account the needs of the region.

38. The workshop recommended that the United Nations Programme on Space Applications should:

(a) Promote, on a priority basis, specialized training in the use and applications of GNSS for the benefit of personnel involved in air navigation in the region. That could be achieved by arranging a short-term training programme that would enable the participants to acquire the skills and expertise needed to guarantee air navigation technical support at various levels;

(b) Conduct a survey on GNSS training centres in the region and support the establishment of regional GNSS training and research centres that would include the participation of governmental and civil aviation entities and universities. The establishment of such centres should be supported in areas where none existed;

(c) In research areas identified as priorities for the region, establish an internship programme at GNSS research and development centres where there was direct support from industry at the international level for personnel directly employed in air navigation;

(d) Identify international opportunities for establishing bilateral and multilateral technical cooperation agreements to facilitate the use and applications of GNSS and facilitate the preparation of such agreements on the basis of the regional needs from the point of view of the beneficiaries of technology transfer;

(e) Urge and assist countries to carry out information programmes on the opportunities and benefits provided by GNSS in different areas of application, in order to ensure the participation of different economic sectors in their implementation. Universities and research institutes would need to play a special role in such efforts with a view to attaining high standards of training in line with the needs of the region;

(f) Assist the region in identifying and assessing different scenarios for GNSS implementation, in particular with regard to the interoperability of SBAS in the region;

(g) Support cost-effectiveness analyses of GNSS implementation in civil aviation with respect to air traffic service providers and to users in general;

(h) Support activities of States aimed at their direct association with GNSS technology, concept formulation and participation in a GNSS development programme in the region.

C. GNSS applications to support disaster management

Observations

39. The workshop noted that there was a lack of regional seminars or organizations to promote the use of GNSS in disaster management in the region and that there was little sharing of experiences. It also noted that the few data banks that existed had diverse formats and procedures and thus required standardization and updating. The availability of high-precision equipment was also limited.

Recommendations

40. Through the United Nations, coordination among the member countries of the Ibero-American Association of Governmental Civil Defence and Protection Bodies should be encouraged with a view to formulating policies with their respective countries on the use of GNSS in support of disaster prevention, mitigation and preparedness. That would make it possible, inter alia:

(a) To disseminate among national prevention bodies a compilation of proven experiences in the use of GNSS in the prevention and mitigation of natural disasters;

(b) To promote, through an international body, the establishment of a standard network of regional users;

(c) To hold seminars for technical and disaster management personnel on methodologies relating to proven experiences to enable the sharing of different alternative uses of global navigation satellite systems;

(d) To expedite the adoption of the Geocentric Reference System for the Americas (SIRGAS), since the lack of georeferencing systems was the main obstacle to achieving standard cartography, which would enable the use of GNSS applications with geographic information systems (GIS).

41. The workshop noted that, while Latin America did not have the resources to expand the use of GNSS in many applications, some applications specialists had been trained at centres within the region or, in the majority of cases, in Europe and the United States. In that connection, the workshop recommended the establishment of a register of specialists in the region who, with the support of experts, could constitute an educational force that could unite to provide training to the countries of the region in areas identified as priorities. In that way, the countries' resources would be invested in training not a small group of specialists but a greater number of specialists.

42. The workshop recommended that a virtual library in English, Spanish and Portuguese containing basic and advanced technical texts, including textbooks, could be established on the Internet to support the use and applications of GNSS.

43. The international community should be called upon, through the Office for Outer Space Affairs, to provide appropriate assistance to countries of the region in obtaining prior and immediate satellite images of extensive areas affected by natural phenomena such as earthquakes, seaquakes (tsunamis), landslides and flooding and others.

D. GNSS applications for agriculture and natural resources management

Observations

44. The workshop noted that there was a wide range of uses of GNSS in agriculture, including crop and soil monitoring, management of chemical and fertilizer application, irrigation management and the benefits of the use of GNSS for farmers.

45. Although activities relating to precision agriculture were being carried out with the use of GPS in South American countries, the workshop noted the need for less costly options of real-time differential correction for GPS, which was considered essential for several applications in precision agriculture.

46. The workshop noted the usefulness of GPS for building a georeferenced database of coffee plantations and other crops for surveillance purposes.

47. The workshop noted that the difficulties encountered in using GNSS in agriculture included the high cost of GPS real-time differential correction outside the United States, as that service was provided by private companies. High costs of the equipment for the end user also presented an obstacle. Many countries had prohibitive import taxes, which sometimes almost doubled the prices.

48. The workshop noted that there was a need for trained people, at several levels, to properly use the GNSS technology. The people to be trained would include engineers, agronomists, technicians, students and farmers.

49. The workshop recognized the need to promote GNSS technology, as many professionals in many Latin American and Caribbean countries were not aware of the benefits that they could receive from the technology.

Recommendations

50. The workshop recommended that efforts should be increased to strengthen the development of human resources by providing education and training through short-term courses for farmers and technicians and regular courses at universities.

51. The workshop recommended that the use and applications of GNSS in agriculture and natural resources management should be promoted through pilot projects, in order to demonstrate the practical benefits of the GNSS technology.

52. The workshop recommended that the GNSS manufacturers should facilitate the acquisition of equipment by educational and research institutions through special agreements.

53. The workshop recommended that import taxes for GNSS equipment acquisition should be reduced in countries where such taxes were prohibitive.

54. The workshop recommended that Governments in the region should invest in territorial mapping and information systems, allowing for a wider utilization of geospatial technologies, including GNSS.

E. High-accuracy GNSS applications for geodesy and Earth sciences

Observations

55. The workshop considered that duly georeferenced information on the physical environment was a basic factor in promoting sustainable development. There had been a considerable increase in the number of applications that required geomatics data, but the number of specialists in Latin America was small, and postgraduate courses in the region were virtually non-existent.

56. The workshop recognized that the ideal of a geodetically linked America was currently being practically achieved though the development of SIRGAS.

Recommendations

57. The workshop recommended that countries in the region should promote the development of strategies for the implementation and densification of SIRGAS at all levels. The number of continuous tracking stations of GNSS should be increased at the continental level until total coverage was achieved in the region. The workshop also recommended that the SIRGAS reference frame should be considered for defining fundamental data for a regional infrastructure of geographic information, which was coordinated by the Permanent Committee on Spatial Data Infrastructure for the Americas.

58. The sharing of experiences among geomatics experts of the Americas should be encouraged, through the promotion of technical assistance for the training and development of skills of specialists. Governments of the Americas should be involved in the development and implementation of postgraduate programmes in geodesy and geomatics.

59. The workshop recommended that the intensive and extensive use of GNSS data in the widest variety of applications should be fostered on the basis of pilot projects involving the largest number of countries of the region.

60. The workshop also recommended that necessary mechanisms should be created in order for the Office for Outer Space Affairs to serve as a channel for the distribution of images from the China-Brazil Earth Resources Satellite in the Americas.

F. Education and training in the use and applications of GNSS

Observations

61. The workshop noted that developing countries urgently needed qualified personnel to meet the challenges posed by GNSS and its demanding applications in such areas as aeronautics, geomatics and Earth sciences. In that context, interdisciplinary teams of professionals were increasingly needed to carry out project development.

62. The great variety of equipment available on the market and the large amount of information appearing in the media and on the Internet, led to confusing and potentially harmful situations for developing countries. In that regard, the workshop stressed the need for personnel with proper training.

63. The workshop noted that there were several centres offering specialized courses in GNSS and its applications, covering mainly aeronautics and airspace matters, at the national and regional levels and for the Americas.

Recommendations

64. The workshop recommended that joint projects between education centres in the region should be encouraged in order to avoid duplicating efforts and to manage financial resources efficiently.

65. The workshop recommended that a survey should be conducted at the regional level to identify education centres that provided training in GNSS and to gather information on the type of courses and degrees offered.

66. The workshop recommended the wide dissemination of information on the available tools and procedures for educational and training activities on GNSS organized by international organizations such as the United Nations and the Organization of American States.

67. The workshop recommended that itinerant training courses should be organized at the technical level to provide post-degree programmes.

68. The workshop recommended the intensive use of the Internet to increase the number of discussion boards related to GNSS training and to provide specialized texts in Spanish and Portuguese.

69. The workshop recommended that a project to carry out a cost-benefit analysis on the use of GNSS should be supported, as it would facilitate the allocation of government resources to education and promote the use of GNSS to satisfy the needs of societies.

70. The workshop recommended that manufacturers of equipment should be encouraged to cooperate with the educational institutions and make services and equipment available to them.