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Report on the United Nations/Latvia Workshop on the Applications of Global Navigation Satellite Systems

(Riga, 14-18 May 2012)

I. Introduction

1. In "The Space Millennium: Vienna Declaration on Space and Human Development",[1] the States participating in the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999, recommended that activities of the United Nations Programme on Space Applications promote collaborative participation among Member States at both the regional and the international levels by emphasizing the development of knowledge and skills in developing countries and countries with economies in transition.

2. In order to promote the use of global navigation satellite systems (GNSS) and their applications in developing countries and in countries with economies in transition, the Office for Outer Space Affairs of the Secretariat, within the framework of the United Nations Programme on Space Applications, organized a series of workshops on applications of GNSS. The central theme of the workshops is GNSS technology, data collection technology and the large number of applications in a wide variety of fields.

3. Regional workshops on applications of GNSS, organized by the United Nations, the European Space Agency (ESA) and the International Committee on GNSS (ICG), were hosted by the Government of China (see A/AC.105/883) and the

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

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Government of Zambia (see A/AC.105/876) in 2006, the Government of Colombia (see A/AC.105/920) in 2008, the Government of Azerbaijan (see A/AC.105/946) in 2009, the Government of the Republic of Moldova (see A/AC.105/974) in 2010 and the Government of the United Arab Emirates (see A/AC.105/988) in 2011.

4. The United Nations International Meeting on the Applications of Global Navigation Satellite Systems, held in Vienna from 12 to 16 December 2011, brought together providers and users of positioning, navigation and timing services to define a way forward in building on the projects and recommendations emanating from previous workshops (see A/AC.105/1019). Those workshops had focused on building capacity, specifically by deploying instruments for the International Space Weather Initiative, developing a GNSS educational curriculum, utilizing regional reference frames and applying GNSS in various areas to support sustainable development.

5. At its fifty-fourth session, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and expert meetings related to natural resources management, basic space technology, human space technology, space weather, GNSS, socioeconomic benefits and space law to be held in 2012 for the benefit of developing countries (see A/66/20, para. 80). Subsequently, the General Assembly, in its resolution 66/71, endorsed the United Nations Programme on Space Applications for 2012.

6. Pursuant to General Assembly resolution 66/71 and as part of the United Nations Programme on Space Applications, the Office for Outer Space Affairs held the United Nations/Latvia Workshop on the Applications of Global Navigation Satellite Systems in Riga from 14 to 18 May 2012. The Workshop was co-sponsored by the United States of America (through ICG) and ESA.

7. The present report presents the background and objectives of the Workshop and provides a summary of the conclusions, observations and recommendations made by the Workshop participants.

A. Background and objectives

8. GNSS refers collectively to all of the satellite navigation systems in operation or being developed around the world known as the Global Positioning System (GPS) of the United States, the Global Navigation Satellite System (GLONASS) of the Russian Federation, Galileo of the European Union and Compass/BeiDou of China. In addition, these systems are supplemented by space-based augmentation systems or ground-based augmentation systems. Examples of space-based augmentation systems are the United States Wide-area Augmentation System, the Russian System for Differential Correction and Monitoring, the European Geostationary Navigation Overlay Service, the Indian GPS-aided Geo-Augmented Navigation and the Japanese Multi-functional Transport Satellite Satellite-based Augmentation System. These systems augment the existing medium-Earth orbit satellite constellations with geostationary or geosynchronous satellites signals or other environmental factors, which may impact the signal received by the users. Using several or all of the GNSS satellites in orbit, productivity typically increases, as well as accuracy, compared with using only one system.

9. In an attempt to build a system of systems in the coming decade, ICG was established in December 2005 at an international meeting at the United Nations Office at Vienna as an informal, voluntary forum to promote cooperation, as appropriate, on matters of mutual interest related to civil satellite-based positioning, navigation, timing and value-added services, as well as the compatibility and interoperability of GNSS, while increasing their use to support sustainable development, particularly in developing countries. Details on ICG are available at the ICG information portal (www.unoosa.org).

10. To support the work of ICG, the Office for Outer Space Affairs, as the ICG executive secretariat, is focusing on promoting the use of GNSS technologies as tools for scientific applications, including the effects of space weather on GNSS, education and training on GNSS, and utilizing regional reference systems and reference frames. Additional information is available from the website of the Office for Outer Space Affairs (www.unoosa.org).

11. Globally, there is growing interest in better understanding solar-terrestrial interactions, particularly patterns and trends in space weather, not only for scientific reasons but also because the reliable operation of ground-based and space-based assets and infrastructures is increasingly dependent on their robustness vis-à-vis the detrimental effects of space weather. Currently, more than 1,000 instruments are operational in 14 ground-based instrument arrays worldwide (GPS receivers, radio antennas, magnetometers and cosmic ray detectors) for research on climate change, space weather and ionospheric phenomena. These instrument arrays have been utilized to constitute the International Space Weather Initiative in the period 2010-2012. Details on the Initiative are available from its website (www.iswi-secretariat.org).

12. The specific objectives of the five-day workshop were: (a) to provide an update on ongoing activities related to the use of GNSS technology in participating countries; (b) to enhance institutional and human capacity in utilizing GNSS technology using case studies, lessons learned and experiences from other countries; (c) to identify the specific needs of ongoing individual plans and projects on GNSS at the regional and international levels for near-, medium-, and long-term applications, taking into consideration the local institutional settings, including specific training and capacity-building needs; (d) to develop a regional plan of action that would contribute to the wider use of GNSS technology and its applications, including the possibility of one or more national or regional pilot projects in which interested institutions could incorporate the use of GNSS technology; and (e) to define recommendations and findings to be forwarded as a contribution to ICG. Thus, the overarching objective was to facilitate cooperation in applying GNSS solutions through the exchange of information and scaling up of capacities among countries in the region.

B. Programme

13. At the opening of the Workshop, introductory and welcoming statements were made by the Parliamentary Secretary of the Ministry of Defence of Latvia, the Director of the Communications Department of the Ministry of Transport of the Republic of Latvia, the Deputy Director of the Latvian Geospatial Information

Agency, a representative of the Office for Outer Space Affairs, and representatives of the United States State Department and ESA as co-sponsors of the Workshop. A representative of the United Kingdom-based Nottingham Scientific Ltd. made a keynote presentation entitled “Multi-GNSS opportunities and challenges to GNSS-enabling technology and its applications”.

14. A total of 41 presentations were made by invited speakers from both developing and developed countries during the five thematic sessions, which focused on GNSS and satellite-based augmentation systems in operation and in development; initiatives in GNSS end-user applications; GNSS reference station networks and services; capacity-building; and training and education in the field of GNSS. Additionally, two panel discussions were held, on the topics “Training and education programme options” and “Developing partnerships and networks”. Four discussion sessions enabled further deliberation on how GNSS-enabling technologies could strengthen a network of national reference stations and promote the interoperability of navigation, positioning, and timing systems in the region.

15. To demonstrate the Ventspils 32-metre radiotelescope (RT-32), a technical tour of the Ventspils International Radio Astronomy Center was organized.

C. Attendance

16. Representatives of universities, research institutions, national space agencies, international organizations and industry, from developing and developed countries, involved in all the aspects of GNSS covered by the Workshop, were invited to participate in the Workshop. Participants were selected on the basis of their scientific background and their experience in programmes and projects in GNSS technology and their applications.

17. Funds provided by the United Nations, the Government of the United States (through ICG) and ESA were used to defray the costs of air travel and accommodation for 22 participants. A total of 75 specialists in satellite navigation systems were invited to attend the Workshop.

18. The following 27 Member States were represented at the Workshop: Albania, Australia, Austria, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Hungary, Israel, Japan, Latvia, Republic of Moldova, Romania, Russian Federation, Sweden, United Kingdom of Great Britain and Northern Ireland, United States, Uzbekistan and Yemen. The Office for Outer Space Affairs and ESA were also represented.

II. Summary of presentations

19. Brief presentations and statements by panellists at the beginning of each session provided participants with the opportunity to share and receive up-to-date information on existing or planned satellite-based navigation systems for use in a wide range of GNSS applications in areas such as surveying, mapping and asset management, precision agriculture, engineering and construction, aviation and maritime navigation, as well as in space weather monitoring and GNSS reference stations networks and services.

20. The presentations made at the Workshop and the abstracts of the papers, as well as the Workshop programme and background materials, are available on the website of the Office for Outer Space Affairs.

III. Summary of discussions and recommendations

21. During different sessions of the Workshop, participants were grouped on the basis of their areas of expertise and interest: GNSS applications and space weather effects on GNSS; regional reference frames and systems; and GNSS educational programmes. Each working group met to discuss activities that would contribute to an increase in the use of GNSS technology in the region, and how best to implement a GNSS continuously operating reference station (CORS) to ensure that data and services are consistent with the national reference frame. The suitability of data from a particular GNSS CORS site or service for their intended application was also discussed. Finally, contributions were made on how capacity-building can strengthen the use of GNSS in various areas of applications. The recommendations resulting from the working group sessions were presented in a plenary meeting for discussion and are summarized below.

A. Working group on GNSS applications and space weather effects on GNSS

22. As GNSS was recognized as a public good and a component of the national infrastructure, the working group noted that the development of GNSS applications that utilize positioning, navigation and timing services should be encouraged in order to foster economic growth and improvements in the quality of life and well-being of populations. It was also noted that development of low-cost GNSS applications accessible to the general public should be particularly encouraged.

23. Participants identified numerous natural and artificial (both intentional and unintentional) threats to GNSS operation and recommended that efforts should be increased to assure the protection of the GNSS radio spectrum and GNSS signal integrity.

24. It was also noted that the development and utilization of the GNSS vulnerabilities and risk mitigation techniques, related both to space weather and artificially induced vulnerabilities and risks, should be considered and that international cooperation in identification and mitigation of GNSS vulnerabilities and risks might be the most effective approach.

25. Participants noted that there should be increased efforts to address the development of GNSS applications in the field of navigation, mobility management and disaster response, along with GNSS surveying applications. It was therefore recommended that practical cooperation and joint training programmes focusing on specific areas of interest to end-users and the professionals involved in the GNSS application development and utilization be organized. It was also recommended that more intensive exchanges and sharing of information be encouraged. Finally, the participants recommended the continuous assessment of the potential utilization of new and emerging technologies and approaches using GNSS.

26. Participants noted that in various applications aimed at supporting sustainable economic and social development, there was tremendous scope for the application of multi-GNSS. The development and utilization of multi-GNSS applications and combined GNSS receivers was therefore recommended for the detection of deterioration of GNSS performance and the increased robustness of GNSS applications.

27. The value of mobile crowdsourcing and geospatial data and information in disaster management, and the development of collaborative application platforms, such as geowikis (e.g. www.geo-wiki.org), were recognized as initiatives in which GNSS applications could provide critical support.

28. It was suggested that GNSS operators monitoring continuous GNSS performance and the quality of service of positioning, navigation, and timing publish regular reports in that regard for the purpose of research and case study reconstruction.

29. Participants recognized that the website of the Office for Outer Space Affairs was vital for disseminating information and recommended that the Office further develop its website, in particular the ICG information portal.

30. To support GNSS applications development, the participants recommended compiling and maintaining a catalogue of case studies and best practices. Participants highlighted the importance of encouraging cooperation on GNSS performance data exchange and data processing, the organization of summer schools and seminars, and joint research and technological projects between countries at the regional, interregional and international levels.

B. Working group on regional reference frames and systems

31. Participants held discussions on ways and means of following up geodetic framework projects, based on continuous observation and analysis of GNSS data that could support many geospatial applications across the region.

32. In the course of the discussions, the participants agreed to provide information about the reference frames currently used by their countries and their relation to the International Terrestrial Reference Frame.

33. It was also agreed that a consolidated list of reference frames and systems used by national authorities, agencies or regional organizations, and their prospective plans for future development, should be made available on the ICG information portal.

34. The utilization of the GNSS real time kinematic technique had encouraged users to apply GNSS reference receivers to support the growing number of applications of high-accuracy positioning for engineering, precision agriculture and other endeavours. In that regard, the working group called for the set-up of more permanent stations, or for the consolidation of the existing dense GNSS continuously operating reference station network infrastructure in order to improve the accuracy of national reference frames.

35. Participants noted that integration of the national GNSS reference stations into the continental reference frame is needed for common processing and to ensure

consistency with the International Terrestrial Reference Frame. It was also noted that the links between national coordinate reference systems and regional frames were necessary in order to carry out the transformation between national and regional frames.

36. Participants proposed to examine the concepts of four-dimensional datums and the development of deformation models that incorporate the effects of events such as earthquakes.

37. It was agreed to continue the practice of the annual cumulative computation of kinematic parameters of the different reference frames. It was also agreed to prepare the description of the models and tools necessary to manage coordinate changes over time and to propose mathematical approaches to improve management practices. Research on applying those models to geospatial data sets (for example, through the use of geographic information systems) was deemed to be necessary.

C. Global navigation satellite system educational programmes

38. Participants noted that the development of a GNSS educational curriculum had been pursued in a series of regional workshops on applications of GNSS organized by the United Nations, ESA and ICG since 2006. From 2008 to 2010, the ICG executive secretariat had taken the lead in organizing training courses on satellite navigation and location-based services in all regional centres for space science and technology education, affiliated to the United Nations. Those training courses addressed GNSS technology and its applications, including hands-on experience with off-the-shelf software for specific applications and GNSS signal processing and facilitated the further development of the GNSS educational curriculum.

39. Participants recognized that the work of ICG, particularly in establishing interoperability among global systems, would allow a GNSS user to utilize one instrument to receive signals from multiple satellite systems. That would provide additional data, particularly in urban and mountainous areas, and greater accuracy of timing and positioning measurements. To benefit from those achievements, GNSS users needed to stay abreast of the latest developments in GNSS-related areas and build the capacity to use the GNSS signal.

40. In that context, participants noted that it was essential to ensure that there were adequate educational programmes to prepare a workforce for the growing opportunities in the GNSS sector.

41. On the basis of the discussions, participants noted that there was a need to facilitate the exchange of information among universities and to promote creation of a regional GNSS university network.

42. Participants also noted that a common educational GNSS programme should be created to be shared by the educational actors. The participants agreed to contribute to that programme by different possible means (e.g. the provision of educational material, tutorials and expertise). It was recommended to promote the use of GNSS information for scientific applications (e.g. space weather monitoring, geodynamics and ionospheric studies).

43. Participants recommended the establishment of a complete list of open source software and training resources to be included in the ICG information portal.

44. Participants recognized the need for additional workshops and training courses that would build upon the results of the current workshop.

45. Participants expressed their appreciation to the Latvian Geospatial Information Agency for their hospitality and the substance and the organization of the workshop.

46. Participants also expressed their appreciation for the significant support provided by the United Nations, as well as by the Government of Latvia, the Government of the United States and ESA.