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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Argentina workshop on the applications of global navigation satellite systems

(Falda del Carmen, 19–23 March 2018)

I. Introduction

1. The number of global navigation satellite systems (GNSS) providing information on position, velocity and time on a global scale has increased significantly since the first such system was established. A new generation of systems is now being deployed, and a variety are available on a regional scale.

2. The International Committee on Global Navigation Satellite Systems (ICG), established in 2005, under the umbrella of the United Nations, serves to promote cooperation on matters related to GNSS. ICG works to enhance coordination among providers of GNSS and regional and augmentation systems in order to ensure compatibility, interoperability and transparency, and to promote the greater use of GNSS capabilities to support sustainable development, particularly in developing nations. ICG also assists GNSS users with their development plans and applications by encouraging coordination and serving as a focal point for information exchange.

3. The Office for Outer Space Affairs of the Secretariat, in its capacity as the executive secretariat of ICG and its Providers' Forum, promotes the use of GNSS through its programme on GNSS applications and related capacity-building activities.

4. The availability of GNSS and other space-based systems creates unprecedented opportunities, bringing benefits in the areas of emergency management, marine and land monitoring and fleet control, among others. As a result of the availability of GNSS, the development of integrated applications is rapidly expanding.

5. As part of the United Nations Programme on Space Applications, the United Nations/Argentina workshop on the applications of global navigation satellite systems was organized by the Office for Outer Space Affairs in cooperation with the National Commission for Space Activities (CONAE) of Argentina. The workshop was held at the Teófilo Tabanera Space Centre, a facility of CONAE, in Falda del Carmen, Argentina, from 19 to 23 March 2018. It was co-sponsored by the European Union and the United States of America through ICG. The European Space Agency (ESA) also co-sponsored the workshop.

6. Previous regional workshops and international meetings on applications of GNSS organized by the United Nations had been held in China (A/AC.105/883) and Zambia (A/AC.105/876) in 2006, Colombia in 2008 (A/AC.105/920), Azerbaijan

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in 2009 (A/AC.105/946), the Republic of Moldova in 2010 (A/AC.105/974), the United Arab Emirates (A/AC.105/988) and Vienna (hosted by the Office for Outer Space Affairs) (A/AC.105/1019) in 2011, Latvia in 2012 (A/AC.105/1022), Croatia in 2013 (A/AC.105/1055), Trieste, Italy (hosted by the Abdus Salam International Centre for Theoretical Physics) in 2014 (A/AC.105/1087), the Russian Federation in 2015 (A/AC.105/1098), and Nepal in 2016 (A/AC.105/1149). Those workshops addressed a wide array of GNSS applications for socioeconomic benefits and focused on initiating pilot projects and strengthening the networking of GNSS-related institutions in the relevant regions.

7. The present report contains a description of the background, objectives and programme of the workshop, as well as an overview of the observations and recommendations made by participants. It has been prepared for submission to the Committee on the Peaceful Uses of Outer Space at its sixty-second session and to its Scientific and Technical Subcommittee at its fifty-sixth session, both to be held in 2019.

A. Background and objectives

8. The Office for Outer Space Affairs, with the aim of bringing the benefits of space to humankind, promotes international cooperation in the peaceful uses of outer space and strives to build capacity related to space-based technology, services and space law. The Office also promotes the use of space technology as a tool to monitor and achieve the 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development (General Assembly resolution 70/1).

9. GNSS applications can contribute in a wide-reaching fashion to the 2030 Agenda. Direct applications of GNSS technology are found in the following areas: transport and communications, aviation, surveying, mapping and Earth science, the management of natural resources, the environment and disaster management, precision agriculture, mobile applications for high-precision measurements, and the provision of timing information in critical national infrastructures.

10. In particular, this workshop contributed to spreading the use of GNSS in support of the following Sustainable Development Goals:

(a) Sustainable Development Goal 3 (“Ensure healthy lives and promote well-being for all at all ages”). GNSS positioning makes it possible to monitor individual patients, staff and equipment and to direct response teams more efficiently;

(b) Sustainable Development Goal 7 (“Ensure access to affordable, reliable, sustainable and modern energy for all”). GNSS reflectometry techniques can produce scatterometry models to optimize the positioning of offshore wind farms;

(c) Sustainable Development Goal 11 (“Make cities and human settlements inclusive, safe, resilient and sustainable”). GNSS is widely used for urban planning in order to pinpoint structures and reference points for cadastral and urban planning purposes. It also allows the monitoring of ground displacement and the detection of potential structural risks due to such ground movement;

(d) Sustainable Development Goal 15 (“Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss”). GNSS reflectometry offers the potential for monitoring vegetation and biomass. It also has an important role in providing information for global monitoring, such as carbon modelling, greenhouse gas emission inventories and deforestation control.

11. Development projects, applications, services and products using georeferencing require a uniform coordinate reference system. Most countries have some form of national reference frame or system. These reference frames or systems are usually based on a local origin or datum point, which restrict their use to a particular country. This makes cross-border mapping, development and planning projects difficult. Common and uniform continental reference frames and systems therefore need to be

established. In this respect, the Geocentric Reference System for the Americas is responsible for the reference frame for South and Central America.

12. In line with the cross-cutting areas identified in the report of the Committee on the Peaceful Uses of Outer Space (A/AC.105/1137, chap. III), the main objective of the workshop was to enhance the exchange of information between countries on the application of GNSS solutions and, to that end, scale up capacities in Latin America and the Caribbean, including by sharing information on national, regional and global projects that could provide benefits for the region, and thereby enhance cross-fertilization among those projects.

13. The specific objectives of the workshop were as follows: (a) introduce the topic of GNSS and its applications in the areas of transport and communications, aviation, surveying, mapping and Earth science, the management of natural resources, the environment and disaster management, precision agriculture, high-precision mobile application, and the effects of space weather on GNSS; (b) promote the greater exchange of actual experiences with specific applications; (c) encourage greater cooperation in developing partnerships and GNSS networks, in the framework of the regional reference frames; and (d) define recommendations and findings, in particular in forging partnerships to strengthen and deliver capacity-building in the utilization of space science and technology for sustainable economic and social development.

B. Programme

14. At the opening of the workshop, introductory and welcoming statements were made by the Secretary General of CONAE, the representatives of ICG and ESA as co-sponsors, and a representative of the Office for Outer Space Affairs.

15. The Deputy Technical and Administrative Director of CONAE delivered the keynote presentation, focusing on CONAE actions and projects under the national space programme, in the areas of Earth observation, exploration and peaceful uses of outer space, and technological developments for use in space, which was periodically updated and extended to ensure that it was suited to the country's socioeconomic and productive requirements.

16. The workshop's technical sessions, aimed at promoting constructive discussion among participants, covered a wide range of topics related to GNSS technology: an overview of GNSS operations and developments; GNSS reference frames and reference station networks; implementation of GNSS technology; GNSS applications; space weather; capacity-building, education and training in the field of GNSS; international and regional experiences in the use and implementation of GNSS technologies; and national GNSS programmes.

17. During the workshop, a one-and-a-half-day seminar on "GNSS spectrum protection and interference detection and mitigation" was held. The purpose of the seminar was to highlight the importance of GNSS spectrum protection at the national level and explain how to reap the benefits of GNSS, and the seminar contained presentations that demonstrated GNSS jamming and spoofing.

18. In addition, two discussion sessions were held in which participants were split into three working groups. The discussion sessions were preceded by a presentation on the publication entitled *European Global Navigation Satellite System and Copernicus: Supporting the Sustainable Development Goals* (ST/SPACE/71), which had been jointly prepared by the Office for Outer Space Affairs and the European Global Navigation Satellite Systems Agency.

19. The workshop's programme had been developed by the Office for Outer Space Affairs and CONAE in cooperation with ICG and ESA.

20. An informative technical tour of CONAE was organized to give workshop participants an inside look at a satellite-tracking and control facility.

21. The presentations made at the workshop, abstracts of the papers presented, the workshop programme and background materials are available on the website of the Office for Outer Space Affairs at (www.unoosa.org).

C. Attendance

22. Representatives of national space agencies, academia, research institutions, international organizations and industry of developing and developed countries working in the field of the development and use of GNSS for practical applications and scientific exploration were invited to participate in the workshop. Participants were selected on the basis of their scientific or engineering background, the quality of the abstracts of their proposed presentations and their experience in programmes and projects involving GNSS technology and its applications.

23. Funds provided by the United Nations, the Government of Argentina and co-sponsors were used to defray the costs of air travel and accommodation for 27 participants. A total of 73 specialists in GNSS were invited to attend the workshop.

24. The following 22 Member States were represented at the workshop: Argentina, Brazil, China, Colombia, Croatia, Ecuador, Egypt, France, Italy, Japan, Latvia, Mexico, Morocco, Panama, Paraguay, Peru, Russian Federation, Spain, Thailand, Turkey, United States and Venezuela (Bolivarian Republic of). The European Union and ESA were also represented. Representatives of the Office for Outer Space Affairs also participated.

II. Observations and recommendations

25. The workshop addressed the use of GNSS for various applications that provided sustainable social and economic benefits, in particular for developing countries. Current and planned projects using GNSS technology for both practical applications and scientific explorations were presented. Cooperative efforts and international partnerships for capacity-building, training and research were discussed.

26. Two discussion sessions were held as part of the workshop. During the first discussion session, three working groups met in parallel to discuss the following themes: (a) capacity-building and institutional strengthening; (b) a geodetic reference network; and (c) specific GNSS applications. At the second discussion session, the working groups presented the results of their deliberations and formulated a common plan of action for the region. The participants put forward a number of observations and recommendations, which are summarized below.

A. Capacity-building and institutional strengthening

27. The working group on capacity-building and institutional strengthening held discussions on GNSS education and training, as well as on the appropriate format for a regional network to create partnerships for the use of GNSS and related applications, including space weather and its effects on GNSS operations.

28. A further discussion addressed existing capacity-building opportunities offered by national, regional and international institutions, about which participants provided information on ongoing opportunities and programmes.

29. The working group recognized the need to continue building national and regional expertise through the short- and long-term training courses and education offered by the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean and through other academic and thematic centres of excellence worldwide.

30. It was recognized that there was a need to organize short training courses in cooperation with the Office for Outer Space Affairs in order to fully exploit the potential of applications based on multi-GNSS constellations.

31. With a view to strengthening the existing GNSS network in the region, the working group recommended exchanging and disseminating information by email and holding periodic virtual meetings.

B. Geodetic reference network

32. The working group on a geodetic reference network held discussions on geodetic reference frames, taking into consideration General Assembly resolution 69/266 on a global geodetic reference frame for sustainable development. The working group recognized the following:

(a) The importance of a global geodetic reference frame for developing and improving the global spatial infrastructure to attain the Sustainable Development Goals of the 2030 Agenda for Sustainable Development;

(b) The efforts made by the countries of Latin America and the Caribbean to deploy, maintain and continuously improve their GNSS networks for a national-level geodetic reference frame;

(c) The success achieved by the Geocentric Reference System for the Americas in coordinating the operation of the GNSS networks at the regional level and in processing the GNSS data in order to provide the community with the regional GNSS-based geodetic reference frame;

(d) The existence in Latin America and the Caribbean of other observing infrastructures that could enhance the current regional GNSS-based geodetic reference frame, namely:

(i) Satellite laser ranging stations in Arequipa, Peru (a partnership between Peru and the United States), in San Juan, Argentina (a partnership between Argentina and China) and in Brasilia (a partnership between Brazil and the Russian Federation); and a very-long-baseline interferometry station in Fortaleza, Brazil (a partnership between Brazil and the United States);

(ii) The Argentina-German Geodetic Observatory containing facilities for satellite laser ranging, very-long-baseline interferometry and GNSS;

(e) The need to deepen the geodetic knowledge existing in the region in order to attain the highest international standards for the realization of a global geodetic reference frame.

33. The working group recommended developing a capacity-building activity, with the assistance of international experts in the subject matter, to process and analyse satellite laser ranging and very-long-baseline interferometry data in combination with GNSS data, and that this activity would be carried out at the regional level in order to maximize the participation of representatives of the countries of Latin America and the Caribbean.

34. On the basis of the above-mentioned considerations, the working group concluded that, in spite of the progress achieved in the region with respect to the availability of GNSS observing stations and data analysis capabilities, there continued to be a need in several countries of the region for geodetic training at a level more basic than what had already been recommended (see para. 30 above).

35. Given the above-mentioned considerations, the working group recommended:

(a) To implement capacity-building through training courses for the staff of space agencies, focusing in particular on the best use of georeferencing to produce spatial information (for example, images and statistics), and identifying the infrastructure available in the region;

(b) To provide assistance for the acquisition, deployment and operation of GNSS networks in countries that still lack such networks or need to improve them;

(c) To provide assistance for the installation of the vertical component of the global geodetic reference frame;

(d) To implement an outreach programme to promote the use of the observational infrastructure of the Geocentric Reference System for the Americas by related applications, for example, applications related to space weather, monitoring water vapour, augmented navigation assessment (space-based augmentation systems or ground-based augmentation systems) and image processing;

(e) To encourage all geodetic data-producing agencies to implement open access policies for their data.

36. In addition, participants noted that the region had a good GNSS observation infrastructure, operated mostly by cartographic agencies, for the support of georeferencing operations.

37. The working group also recommended that a proposal be prepared for a pilot project to augment the existing GNSS networks in order to transmit real-time differential corrections for multipurpose applications.

C. Global navigation satellite systems applications

38. The discussion of the working group on GNSS applications addressed the three aspects of that topic: the scientific and technical aspect, the organizational aspect, and specific applications. Synergies between those three aspects were also considered.

39. With respect to the scientific and technical aspect of GNSS, the working group recommended:

(a) To consider the incorporation of multiple constellations into space-based augmentation systems, which might have an impact on various services, in particular, civil aviation, and provide benefits for other sectors;

(b) To consider increasing the number of stations of the International Satellite System for Search and Rescue (COSPAS-SARSAT) for search and rescue applications;

(c) To organize a workshop on disaster management using the enhanced capabilities of GNSS, COSPAS-SARSAT and Earth observation.

40. With respect to the organizational aspect, it was recommended that an inventory be made of the equipment, applications and services, and capacity-building opportunities that were available in the region. That inventory could then be used to enhance the communication between institutions in the region.

41. Participants noted that the Office for Outer Space Affairs was currently working on a database containing institutional, country-level and regional solutions that addressed those three aspects (scientific and technical, organizational, and specific applications), and which would be made available to all Member States.

42. With respect to specific applications using GNSS and other technologies, participants recognized the need for additional workshops building upon the results of the present workshop, including workshops focusing on training decision makers and covering the integrated application of combined remote sensing, geographic information systems and decision-support systems.

III. Concluding remarks

43. The recommendations and observations put forward by the participants in the workshop provided guidance on how institutions could work together through

regional partnerships. The Office for Outer Space Affairs should provide support for the consolidation of the partnerships formed at the workshop. Those partnerships would result in the sharing and transfer of knowledge and the development of joint activities and project proposals.

44. In addition, it was recommended that the Office should continue its work on capacity-building through the regional centres for space science and technology education, affiliated with the United Nations, and centres of excellence, and work further to ensure that end users would benefit from multi-constellation GNSS.

45. The participants in the workshop expressed their appreciation to the United Nations, the Government of Argentina and the workshop co-sponsors for the substance and the excellent organization of the workshop.