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Report on the workshop on the applications of global navigation satellite systems

(Suva, 24–28 June 2019)

I. Introduction

1. Current fully operational global navigation satellite systems (GNSS) include the Global Positioning System (GPS) of the United States of America and the Global Navigation Satellite System (GLONASS) of the Russian Federation. Both systems are being modernized to better respond to the challenges of GNSS-based applications. The modernizations include an increase in the number of transmission frequencies and changes to the signal components. In addition, the European Satellite Navigation System (Galileo) of the European Union and the BeiDou Navigation Satellite System of China, currently being developed and deployed, will enhance the quality of services and increase the number of potential users and applications. At the regional level, the Indian Regional Navigation Satellite System (IRNSS) and the Quasi-Zenith Satellite System (QZSS) of Japan, together with several regional augmentation systems, are also available.

2. While GNSS determines a precise position anytime and anywhere on the globe, the integration of GNSS, telecommunication, geographic information systems (GIS) and remote sensing technologies have demonstrated their utility in providing information on the Earth's surface, its atmosphere and marine systems. Therefore, the joint use of space-based technology and services can also support the monitoring and achievement of the Sustainable Development Goals for the benefit of humankind.

3. The Office for Outer Space Affairs of the Secretariat, with the vision of bringing the benefits of space to humankind, has been supporting capacity-building activities with Governments and institutions. The Committee on the Peaceful Uses of Outer Space is also establishing the "Space2030" agenda and its implementation plan to better coordinate activities around the use of space technologies for development purposes.

4. The International Committee on Global Navigation Satellite Systems (ICG), established in 2005, encourages and facilitates compatibility, interoperability and transparency between all satellite navigation systems. ICG also promotes and protects the use of their open service applications, thereby benefiting the global community while increasing their use to support sustainable development, in particular in developing countries.

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5. The Office for Outer Space Affairs, in its capacity as the executive secretariat of ICG and its Providers' Forum, is promoting the use of GNSS throughout its programme on GNSS applications and related capacity-building activities.

6. To focus on GNSS-based technology and its applications, a five-day workshop on the applications of GNSS was held at the University of the South Pacific in Suva from 24 to 28 June 2019. The workshop was organized by the University of the South Pacific, supported by the Office for Outer Space Affairs, and co-sponsored by the European Union and the United States through ICG.

7. The present report contains a description of the background, objectives and programme of the workshop, as well as a summary of the observations and recommendations made by the participants. It has been prepared for submission to the Committee on the Peaceful Uses of Outer Space at its sixty-third session, to be held in 2020, and to its subcommittees.

A. Background and objectives

8. GNSS-based technology continues to develop as a tool for international cooperation among the satellite operators of the current and planned systems. The growing need to locate objects accurately and reliably has wide-ranging implications for the management of the environment and for disaster warning and emergency response, among other areas. The Office for Outer Space Affairs and ICG are working together to raise awareness of the important role of GNSS in our societies and to promote international collaboration in this field. Specific areas of interest to ICG and its working groups include systems, signals and services (Working Group S); the enhancement of GNSS performance, new services and capabilities (Working Group B); education, training and global applications (Working Group C); and timing and geodetic reference frames (Working Group D). More detailed information is available at www.unoosa.org/oosa/en/ourwork/icg/icg.html.

9. In line with the cross-cutting areas, as identified in the draft report of the sixty-second session of the Committee on the Peaceful Uses of Outer Space (A/AC.105/L.318), the main objectives of the workshop were to reinforce the exchange of information between countries and scale up the capacities in the region for pursuing the application of GNSS solutions; to share information on the national, regional and global projects and initiatives, which could benefit the regions; and to enhance cross-fertilization among them.

10. The specific objectives of the workshop were the following:

(a) Introduce GNSS-based technology and its applications;

(b) Promote greater exchange of actual experiences with specific applications;

(c) Encourage greater cooperation in developing partnerships in the region and the network of GNSS continuously operating reference stations;

(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

11. At the opening of the workshop, introductory and welcoming statements were made by the Minister for Infrastructure, Transport, Disaster Management and Meteorological Services of Fiji; the Vice Chancellor and the Dean of the Faculty of Science, Technology and Environment of the University of the South Pacific; and the representative of the Office for Outer Space Affairs.

12. The workshop technical sessions promoted productive discussions among participants. There were over 60 presentations that covered the following wide range of topics related to GNSS-based technology and its applications:

(a) Current status and future trends in GNSS;

(b) GNSS-based applications;

(c) National GNSS programmes and projects;

(d) Space weather;

(e) Geodetic reference networks;

(f) Capacity-building and international and national experiences in the use and implementation of GNSS-based technologies.

13. Consistent with its workplan, the experts of the interference detection and mitigation task force of ICG Working Group S conducted a seminar on 25 and 26 June 2019 on GNSS spectrum protection and interference detection and mitigation. The purpose of the seminar was to describe the importance of GNSS spectrum protection at the national level and to explain how to reap the benefits of GNSS.

14. Additionally, a panel discussion on sustainability and modernization of GNSS continuously operating reference stations and geospatial infrastructure through capacity development was held to provide the community of the Pacific region with information on the importance of planning and its link to the "why, what and how" of developing long-term capability with respect to GNSS and geospatial infrastructure and related activities. The discussions were led by the representatives of the Asia Pacific Capacity Development Network of the International Federation of Surveyors (FIG) and FIG Commission 5, on positioning and measurement; the capacity-building working group of the United Nations Global Geospatial Information Management (UN-GGIM) for Asia and the Pacific Working Group 1, on geodetic reference frames; the focus group on education, training and capacity-building of the UN-GGIM Subcommittee on Geodesy; and the International GNSS Service (IGS).

15. A special technical session on standards and interoperability of precise point positioning services was organized and moderated by the representatives of ICG working groups B and D. The purpose of the session was: (a) to increase awareness of the systems-provided precise point positioning services; (b) to increase the user benefits and opportunities to support positioning, time and navigation applications in developing countries; and (c) to encourage standardization and interoperability of the systems-provided precise point positioning services.

16. The programme was developed by the Office for Outer Space Affairs and the University of the South Pacific in cooperation with ICG working groups.

17. An informative technical tour of the site of the GNSS continuously operating reference stations was organized for participants in the workshop. The tour gave the participants an inside look at the positioning infrastructure in Fiji.

18. The presentations made at the workshop, abstracts of the papers given and the workshop programme are available on the website of the Office for Outer Space Affairs (www.unoosa.org/oosa/en/ourwork/psa/schedule/2019/2019-un-fiji-workshop-on-the-applications-of-gnss.html).

C. Attendance

19. Representatives of national space agencies, academia, research institutions, international organizations and industry from developing and developed countries concerned with 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, carried out in the use of GNSS-based technology and its applications.

20. Funds provided by the United Nations, the University of the South Pacific and co-sponsors were used to defray the costs of air travel and accommodation for 22 participants. A total of 96 specialists were invited to attend the workshop.

21. The following 23 Member States were represented at the workshop: Angola, Australia, China, Cook Islands, Fiji, India, Indonesia, Japan, Kiribati, Malaysia, Mongolia, Mozambique, Myanmar, Nauru, New Zealand, Philippines, Russian Federation, Samoa, Thailand, Tonga, Tuvalu, United States and Vanuatu. The European Space Agency was also represented. The representative of the Office for Outer Space Affairs also participated.

II. Observations and recommendations

22. The workshop addressed the use of GNSS for various applications that could provide sustainable social and economic benefits, in particular for developing countries. There were many presentations and key messages relevant to the workplans of the ICG working groups and the ICG programme on GNSS applications implemented by the Office for Outer Space Affairs. The main points to note were the following:

(a) GNSS had become an essential part of positioning, time and navigation aspects of ground, marine, aviation and space applications. While GNSS modernization programmes were ongoing, all the GNSS systems were significantly expanding their global component capabilities to provide GNSS services that benefit users worldwide;

(b) Research and development opportunities in the area of GNSS were driven by the increasing mass market need for accurate and reliable real-time positioning via portable or mobile devices;

(c) With a view to raising awareness of efforts to achieve the overall goal of promoting effective use of GNSS open services by the global community, it was necessary to understand the issues and importance of GNSS signal protection and its vulnerabilities, the impact and detection of GNSS interference, and methods to protect GNSS signals and mitigate the impact from interference;

(d) As national, regional and international infrastructures, as well as the global economy, were becoming increasingly dependent on services related to positioning, time and navigation, society was vulnerable to disruptions caused by space weather or variable conditions on the sun and in the space environment that could influence space-borne and ground-based technological systems;

(e) Low-cost GNSS positioning devices were becoming an option for users searching for cost-effective technology to georeference information.

23. Each of the presentation sessions included a discussion period focusing on the key challenges and issues presented. The results of the deliberations of the workshop were summarized and presented at the closing session, when a final exchange was held, and the conclusions and recommendations were adopted.

A. Global navigation satellite systems spectrum protection and interference detection and mitigation

24. The workshop noted that GNSS had become critical for national and global economies. The number of applications for GNSS was almost unlimited, ranging from precision agriculture, to precise timing used for automated teller machine transactions, to reliable navigation for the takeoff and landing of aircraft. However, GNSS signals that are broadcast from the satellites are quite weak by the time they

reach the Earth, which results in the services being vulnerable to various sources of interference. In order to address this vulnerability, it is necessary to take appropriate measures to protect the spectrum where GNSS operates. Proper spectrum management at the national and international levels is paramount to enabling GNSS to continue to boost global economies and improve quality of life for GNSS users around the world.

25. The workshop noted that ICG had provided a mechanism for multilateral discussion and coordination on GNSS issues of concern. A core mission of ICG is to promote the introduction and utilization of GNSS services in developing countries. Included in its workplan is a focus on ways to protect the GNSS spectrum from harmful interference and identify ways to detect and mitigate the interference.

26. Participants of the workshop were encouraged to engage with spectrum regulators and decision makers within their respective countries in order to do the following:

(a) Recognize the broad economic, environmental and social benefits that GNSS brings to society;

(b) Increase recognition of the fact that GNSS signals are very vulnerable to intentional and unintentional interference, owing to their relatively weak signal power;

(c) Ensure that there is a solid understanding of the processes and organizations involved in the regulation of the GNSS spectrum in their respective countries;

(d) Develop actions to ensure that there is adequate protection for the GNSS spectrum.

B. Sustainability and modernization of global navigation satellite systems continuously operating reference stations and geospatial infrastructure through capacity development

27. Discussions were held on the key challenges and the issues presented, and resulted in initiatives and actions to move capacity development in the Pacific islands forward. The outcomes of these deliberations included the following:

(a) There was a need for standards and procedures that were fit for purpose, including consolidated checklists that would serve to ensure consistent and sustainable use of GNSS, and related activities in the region;

(b) A request was made for assistance to develop and prepare relevant documentation with respect to GNSS, remote sensing and other measuring devices, including unmanned aerial vehicles and tide gauges, for the measurement and monitoring of sea level rise;

(c) Implementation plans should be based on a shared template that highlights interoperability and applicability to key United Nations initiatives, including the Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction, and the framework and its guidance built upon the existing body of work of UN-GGIM and the World Bank. Furthermore, the focus should be on regional issues such as the rising sea level and disaster resilience management: before, during and after;

(d) A communication framework for the sharing of training opportunities should be developed, enabling efficient use of in-person training provided by academia and industry;

(e) Engagement with the private sector, especially for training, data provision and processing, was encouraged;

(f) There was a need to identify areas of specialization within the organizations, as pertained to GNSS and geodetic surveying. A centralized source for

training and capacity development resources should be established, with these resources appropriately modularized and tagged so as to optimize interoperability, usability and applicability to current and future needs;

(g) It was noted that training needed to be tailored to the available equipment and infrastructure in a particular country or region. It was also noted that it should be appropriately scaled and directed to the identified problems and capability levels in a given country. Follow-up training for the purposes of sustainably maintaining core competencies, as well as for continuing education, was also emphasized;

(h) Collaboration with existing regional entities, such as the Pacific Meteorological Council, for the purpose of developing guidelines for mentorships and internship programmes based on established regional successes was highlighted;

(i) It was reinforced that engagement with local educational and academic institutions was critical to developing capacity, in particular the core geodetic competencies. It was further confirmed by participants that the Office for Outer Space Affairs, the University of the South Pacific, Fiji University, the Pacific Geospatial and Surveying Council and other stakeholders, such as the Royal Melbourne Institute of Technology of Australia, would need to collaborate on future training curricula and opportunities;

(j) It was noted that future workshops in the Pacific region would need to be at least 3 to 5 days' duration, so as to develop the necessary capabilities to implement a practical, incremental and "fit for purpose" approach to subjects, including the following:

(i) Integration of height systems and establishment of a vertical height datum;

(ii) GNSS fundamentals and principles;

(iii) GNSS and reference frames;

(iv) GNSS measurement, processing and adjustment of observations for data;

(v) Transforming data;

(vi) Standards and practices for GNSS measurements, processing and adjustments;

(vii) GNSS data management;

(viii) Importance and value of geospatial information.

C. Standards and interoperability of precise point positioning services

28. Participants noted that access to high accuracy positioning services provided by GNSS and regional navigation satellite systems would serve as an enabler for emerging mass-market high accuracy positioning applications, such as in autonomous systems in transportation, construction, agriculture and location-based service applications.

29. Participants noted that small island developing States were able to benefit from free and open access to high accuracy positioning services provided via satellites and ground communications.

30. Participants agreed that it would be beneficial to discuss further the topic of standardization and interoperability of the system-provided precise point positioning services in ICG.

III. Concluding remarks

31. The recommendations and observations put forward by the participants in the workshop provided guidance on how institutions could work together through regional partnerships. Those partnerships would result in the sharing and transfer of knowledge and the development of joint activities and project proposals.

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

33. The participants expressed their satisfaction with the fact that the workshop had produced real results from which they could continue to benefit in the future. Participants expressed their appreciation to the Office for Outer Space Affairs, the University of the South Pacific, the ICG working groups and the co-sponsors for the hospitality, substance and the excellent organization of the workshop.