UNITED NATIONS
Office for Outer Space Affairs

INFORMATION NOTE

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

Organized jointly by

The United Nations Office for Outer Space Affairs and
Survey Department of the Ministry of Land Reform and Management of Nepal

Co-organized and co-sponsored by

The International Committee on Global Navigation Satellite Systems

Kathmandu, Nepal

12 – 16 December 2016

1. Introduction

Since the beginning of the space age, international cooperation in the peaceful uses of outer space has evolved in such a way as to provide the impetus for a consideration of international mechanisms and infrastructures for space cooperation and coordination mechanisms at the international, regional, interregional and national levels1.

Global navigation satellite systems (GNSS) are the collection of satellite positioning systems that are now operating or planned. Two such systems that are currently in operation include the Global Positioning System (GPS) of the United States of America and the Global Navigation Satellite System (GLONASS) of the Russian Federation. Next-generation systems that are being developed include the European Satellite Navigation System (Galileo) and China's BeiDou Navigation Satellite System. Regional systems that provide additional signals from satellites operating over a given geographical area include the Indian Regional Navigation Satellite System (IRNSS) and Japan's Quasi-Zenith Satellite System (QZSS), which are also compatible with one or more GNSS. Each of those navigation satellite systems will bring extra satellites and signals to deliver better accuracy, reliability and availability. As new systems emerge, signal compatibility and interoperability among the various systems and transparency in the provision of open civil services, will be key factors in ensuring that civil users receive maximum benefit from GNSS applications.

---

1 United Nations Document. Fiftieth anniversary of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space: theme of the sessions of the Committee on the Peaceful Uses of Outer Space, its Scientific and Technical Subcommittee and its Legal Subcommittee in 2018, Notes by the Secretariat, A/AC.105/L.297
(see http://www.unoosa.org/res/oosadoc/data/documents/2015/aac_105l/aac_105l_297_0_html/AC105_L297E.pdf)

Numerous potential applications have already been identified based on the quality and reliability of GNSS signals, but the list is certain to grow, offering a cost-effective way of pursuing sustainable economic growth while protecting the environment.

A five-day workshop on the applications of global navigation satellite systems (GNSS), to be held in Kathmandu, Nepal, from 12 to 16 December 2016, is being organized by the United Nations Office for Outer Space Affairs in cooperation with Survey Department of the Ministry of Land Reform and Management of Nepal as part of the activities of the United Nations Programme on Space Applications. The Workshop is hosted by Department of Survey on behalf of the Government of Nepal. The Workshop is co-sponsored by the Government of the United States of America and the European Union through the International Committee on Global Navigation Satellite Systems (ICG).

The Workshop will address the use of GNSS for various applications that can provide sustainable social and economic benefits, in particular for developing countries. Current and planned projects that use GNSS technology for both practical applications and scientific explorations will be presented. Cooperative efforts and international partnerships for capacity-building, training and research will be discussed.

Building upon cross-cutting areas, in particular resiliency, including matters related to the ability to depend on space systems and to respond to the impact of events such as adverse space weather (see A/AC. 105/L.297), **a one-day seminar on "Space Weather and its effects on GNSS"** will be held during the Workshop. The purpose of the seminar is to provide a background on the phenomena of space weather and illustrate its effects on GNSS. The performance of GNSS, receivers and applications can be adversely affected by space weather phenomena whose occurrence is generally correlated with the 11-year solar cycle. This seminar will describe the challenging aspects of space weather phenomena, their impact on GNSS users, the variability of these impacts and the actions that may mitigate their effects.

This seminar will be conducted in coordination with the ICG Working Group on Capacity Building and Information Dissemination. The topics of the seminar will be built from the experience of the space weather experts who will lead this seminar. The speakers in this seminar will come from a wide variety of professional backgrounds, and will form a highly knowledgeable team of experts.

2. Background

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. ICG was established in 2005 under the umbrella of the United Nations. ICG and its Providers' Forum work to promote the introduction and utilization of GNSS services and their future enhancements, including in developing countries, providing assistance, as necessary, for the integration of GNSS into existing infrastructure. ICG also assists GNSS users with their development plans and applications by encouraging coordination and serving as a focal point for information exchange. **Participation in ICG is open to all countries and entities that are either GNSS providers or users of GNSS services and that are interested and willing to actively be engaged in the ICG activities.** Additional information is available at: www.unoosa.org

Building resilient societies through better coordination and forging of global partnerships is one of the key challenges in the 21st century and an integral part of meeting the commitments set by the 2030 Agenda for Sustainable Development. Recognizing space weather as a global challenge and the need to address the vulnerability of society as a whole, one of the potential activities of ICG is to address the importance of space weather for GNSS systems and their users. **Space weather is defined as "the conditions on the sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems, as well as endanger life and health".** Space weather can interrupt communication and navigation systems; harm satellite electronics; and expose aircraft passengers flying over the poles and very high altitudes to increased levels of radiation. For GNSS users, space weather is the single largest contributor to the single frequency GPS error budget, and a significant factor for differential GNSS users. Since more and more

nations of the world are becoming dependent on GNSS systems and signals, it is necessary to inform and educate users of the threat of space weather on GNSS systems and applications. Additional information is available at: http://www.iswi-secretariat.org/ and http://www.unoosa.org/oosa/en/ourwork/icg/space-weather-and-gnss.html

Efforts to build capacity in space science and technology are considered a major focus of the Office for Outer Space Affairs and are of specific interest to ICG with particular reference to GNSS and its applications. Such efforts aim to provide support to the regional centres for space science and technology education affiliated to the United Nations, which also act as information centres for ICG. **The ICG information centres are working towards the establishment of a network of institutions involved or interested in GNSS. They are also identifying new applications that could be developed in the regions on the basis of GNSS services.** The centres coordinate their activities closely with ICG and its Providers' Forum through the ICG executive secretariat. Additional information is available at: http://www.unoosa.org/oosa/en/SAP/centres/index.html

Development projects, applications, services or products requiring georeferencing, require a uniform coordinate reference system. Most countries have some form of national reference frame or system. These reference frames/systems are usually based on local origin or datum point, which restrict their use to a particular country. It makes cross-border mapping, development and planning projects difficult, and therefore calls for the establishment of a common and uniform continental reference coordinates frames and systems. Additional information is available at:
http://www.unoosa.org/oosa/en/SAP/gnss/icg/regrefsys.html

The discussions at the Workshop will also be linked to the 2030 Agenda for Sustainable Development and to its targets set out for Sustainable Development Goals, such as, *Health* (GNSS positioning enables individual patients, staff or equipment to be monitored, and response teams directed more efficiently); *Energy* (GNSS reflectometry techniques can produce scatterometry models to assist in the optimum positioning of off-shore wind farms); and *Ecosystems* (GNSS reflectometry offers the potential for monitoring vegetation and biomass. It also has an important role in providing information for global monitors such as: carbon modelling, greenhouse gas emission inventories and deforestation control).

The Workshop will also be informed about the preparations towards the **fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50**), which will be held in 2018. Information about a series of high level fora: Space as a Driver for Socioeconomic Sustainable Development, to be organized by the Office for Outer Space Affairs in 2016 through 2018, will also be presented. These series of fora will address the cross-sectoral impact of integrating economic, environmental, social, policy and regulatory dimensions of space in pursuance of global sustainable development.

2018: UNISPACE+50 years of space cooperation and development

UNISPACE+50 will take stock of the contributions of the three UNISPACE conferences (UNISPACE I, held in 1968, UNISPACE II, held in 1982 and UNISPACE III, held in 1999) to global space governance. In line with the 2030 Agenda for Sustainable Development and sustainable development goals, UNISPACE+50 aims to chart the future role of the Committee on the Peaceful Uses of Outer Space (COPUOS), its subsidiary bodies and the United Nations Office of Outer Space Affairs at a time of an evolving and more complex space agenda when more actors, both governmental and non-governmental, are increasingly involved in space activities. The activities of the United Nations Programme on Space Applications are an integral part of the UNISPACE+50 thematic cycle, contributing to space economy, space society, space accessibility and space diplomacy. More detailed information is available at the website of the Office for Outer Space Affairs:
http://www.unoosa.org/oosa/en/aboutus/history/unispace.html

3. Objectives and Expected Outcomes

In line with the cross-cutting areas, as identified in document A/AC.105/L.297, the main objective focuses on the importance and need of cooperation to apply GNSS solutions through the exchange of information and the scaling up of capacities among countries in the region.

In order to strengthen the ongoing processes in the lead up to UNISPACE+50, the specific objectives of the workshop are: (a) to introduce GNSS and its applications to transport and communications, aviation, surveying, mapping and Earth science, management of natural resources, the environment and disasters, precision agriculture; high precision mobile application, as well as space weather effects on GNSS and dual-frequency receivers; (b) to promote greater exchange of actual experiences with specific applications; (c) to encourage greater cooperation in developing partnerships and GNSS networks, in the framework of the regional reference frames; (d) define recommendations and findings to be forwarded as a contribution to the ICG and UNISPACE+50, in particular in forging partnerships to strengthen and deliver capacity-building in the use and applications of space science and technology, fit for the 21st century.

The expected outcomes of the Workshop are: (a) recommendations and findings on discussed topics to be adopted by the Workshop participants; (b) preliminary agreement of cooperation between countries in the region and the GNSS continuously operating reference station (CORS) networks; (c) action plan addressing identified issues/concerns.

4. Preliminary programme of the Workshop

The Workshop programme will include plenary sessions and sufficient time for discussions among participants to identify the priority areas where pilot projects should be launched and examine possible partnerships that could be established. A one-day seminar on "Space Weather and its effects on GNSS" will be held during the Workshop. A half-day technical tour will be arranged by the Local Organizing Committee during the Workshop. As a preliminary suggestion the following sessions will be organised:

Thematic Sessions

Session 1: Current and planned GNSS and satellite-based augmentation systems

- Programme updates on GNSS and satellite-based augmentation systems: Global Positioning System (GPS) and Wide-Area Augmentation System (WAAS), GLObal NAvigation Satellite System (GLONASS) and System of Differential Correction and Monitoring (SDCM), European Satellite Navigation System (GALILEO) and the European Geostationary Navigation Overlay Service (EGNOS), BeiDou Navigation Satellite System (BDS), Indian Regional Navigation System (IRNSS) and GPS Aided Geo-Augmented Navigation (GAGAN), Quasi-Zenith Satellite System (QZSS).

Session 2: GNSS-based applications focusing on, but not limited to

- Advances and performance benefits due to multi-sensor integration of GNSS applications in surveying and geodesy;
- The use of GNSS for aviation, including integration of satellite navigation technology into air traffic management and airport surface navigation and guidance;
- The use of navigation and timing systems for road, rail, and engineering applications, including vehicle guidance, geographic information system (GIS) mapping, and precision farming;
- Location Based Services: GNSS-enabled mobile phones and services, including the early warning in a hazard area;

- Commercial applications of GNSS.

Session 3: GNSS spectrum protection and interference detection and mitigation

- ICG activities and its role in spectrum protection and interference detection and mitigation.

Session 4: GNSS reference frames/systems and reference station networks

- Programme updates on regional and national reference frames/systems and perspectives for a regional cooperative mechanism;
- International GNSS Service (IGS), the United Nations Initiative on Global Geospatial Information Management (UN-GGIM) and other initiatives, Continuously Operating Reference Stations (CORS) network and multi-GNSS environment.

Session 5: Capacity building, training and education in the field of GNSS

- GNSS education opportunities at different levels/needs;
- The strengthening of a specialized master's programmes for long-term professional education and support to PhD training and networking in GNSS;
- GNSS education tools/open source software related to GNSS.

Discussion Sessions

- Issues, concerns and approaches for pilot projects/initiatives, requirements of implementing, mechanisms and resources of implementing;
- Possible follow-up projects and initiatives and proposals for future workshops/training courses/technical seminars;
- Define recommendations/observation to be forwarded as a contribution to ICG and its working groups and UNISPACE+50.

5. Preliminary Agenda of Seminar "SPACE WEATHER AND ITS EFFECTS ON GNSS"

The seminar will primarily be given in three parts. The first part will describe general space weather phenomena. The second part will focus on ionospheric physics and how the ionosphere affects GNSS signals under quiet and disturbed conditions. The final part of the seminar will illustrate the effects that space weather has shown on GNSS systems and applications. It will also discuss the importance of space weather forecasting for GNSS users and the current state of space weather forecasting.

Part I:

The first part of the seminar will describe the general phenomena of space weather including the Sun and its variability; the major solar eruptions and radiation storms that challenge the space environment; and the Sun-Earth connection.

Part II:

The seminar will continue with more detailed presentations on the physics of the ionosphere. GNSS signals propagating from a satellite to the user must pass through the ionosphere where the signal can be modified causing ranging errors and time delays due to the presence of the ionosphere's free electrons. Under nominal conditions, when the Sun is quiet, the modifications of the signal can be readily estimated and removed from the observations. However, under disturbed solar conditions, ionospheric electron density becomes so variable that it can induce loss of lock on the GNSS signal and increase ranging errors. This part of the seminar will provide information on these processes and the resultant gradients and

scintillation on a worldwide ionospheric perspective.

Part III:

This final section of the seminar will focus on observations of GNSS system and user performance under nominal and disturbed conditions. It will also provide information on the importance and the current state of forecasting space weather in order to mitigate the damaging effects of space weather.

This seminar will be conducted in coordination with the ICG Working Group on Capacity Building and Information Dissemination. The topics of the seminar will be built from the experience of the space weather experts, who will lead this seminar.

The seminar will also provide ample time for discussion open to all participants, and will address in-depth questions and answers on specific topics unique to a particular region.

6. Working Methods

Participants of the Workshop are requested to deliver a presentation paper and materials covering information on the use of GNSS technology, case studies/projects in GNSS applications in their respective countries. Each speaker is allocated 20 minutes for the presentation. It is also necessary to submit an abstract of presentation with a maximum of 600 words including the following details: *Paper Title, Author (s) Name(s), Affiliation(s), and e-mail address for the presenting author.*

Presentations made at the workshop will be published on the website of the Office for Outer Space Affairs (www.unoosa.org) approximately two weeks after the Workshop concluded.

7. Sponsorship of the Workshop

The Office for Outer Space Affairs of the United Nations and Survey Department of the Ministry of Land Reform and Management of Nepal are responsible for organizing the Workshop. The United States of America and the European Union through the ICG are co-sponsors of the Workshop. **Sponsorship of the Workshop is still open to the ICG membership and other interested entities.**

8. Expected participants

The Workshop is being planned for a total of 75 participants including scientists, engineers, university educators, and policy-and-decision makers and senior experts from the following groups: international, regional, national and local institutions, United Nations agencies, intergovernmental and non-governmental organizations, research and development institutions, and also from industry.

9. Participation requirements

Participants should be in senior managerial or decision-making responsibility at governmental agencies, national and regional institutions, intergovernmental and non-governmental organizations or industry. **Equally qualified female applicants are particularly encouraged.**

10. Language of the Workshop

The working language of the Workshop will be English.

11. Financial support

Within the limited financial resources available, a number of selected participants will be offered financial support to attend the Workshop. This financial support will defray the cost of travel (a round trip airticket – most economic fare – between the airport of international departure in their home country and

Kathmandu, Nepal) and/or the room and board expenses for the duration of the Workshop. The co-sponsors of the Workshop will jointly select participants on a competitive basis. Successful applicants will be notified by within four weeks of the deadline after submitting the application.

12. Deadline for Submission of Applications and Abstracts

The completed application form together with the presentation abstract should be submitted on-line, to the Office for Outer Space Affairs, **no later than Friday, 30 September 2016 (*for applicants seeking financial support*)** and **no later than Friday, 28 October 2016 (*for applicants, who are self-funded or are being funded by their own organizations*).** Only complete applications with all the requested information and signatures will be considered by the Workshop Organizing Committee. Please note that on-line application form is available on the web site of the Office for Outer Space Affairs at the following addresses:

https://register.unoosa.org/civicrm/event/info?id=65&reset=1 (***for applicants seeking financial support)***

and

https://register.unoosa.org/civicrm/event/info?id=66&reset=1 (***or applicants, who are self-funded or are being funded by their own organizations)***

13. Life and Health Insurance

Life/major health insurance for each of the selected participants is necessary and **is the responsibility of the candidate or his/her institution or Government.** The co-sponsors will not assume any responsibility for life and major health insurance, nor for expenses related to medical treatment or accidents.

14. Further Information and Contact Details

For information regarding the submission of nominations for attendance and funding, please contact **Mr. Christopher STO.DOMINGO**, United Nations Office for Outer Space Affairs, at the following e-mail address: Christopher.sto.domingo@unoosa.org

For information regarding the programme, presentations/abstracts and speakers of the Workshop, please contact **Ms. Sharafat GADIMOVA**, United Nations Office for Outer Space Affairs, at: gnss@unoosa.org

The focal point for Nepal will be **Mr. Niraj MANANDHAR**, Survey Department, the Ministry of Land Reform and Management, Nepal, who can be contacted at the following e-mail address: unnepalworkshop@gmail.com