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United Nations/United States of America Workshop on the Use of Global Navigation Satellite Systems

(Kuala Lumpur, 20-24 August 2001)

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I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) and the Vienna Declaration on Space and Human Development recommended that activities of the United Nations Programme on Space Applications promote collaborative participation among Member States at both the regional and international levels, emphasizing the development of knowledge and skills in developing countries.[1]

2. The Global Navigation Satellite System (GNSS) is one of the most promising space applications that can be used to achieve the recommendations made by UNISPACE III. The need has been identified to determine precise locations on the ground for use with Earth observation images and ancillary information in geographical information systems (GIS). Such location information is needed for a large number of remote sensing applications, some of which support such strategic areas for development as disaster management, monitoring and protecting the environment, management of natural resources and food production. With the availability of high-resolution images, certain applications will require a location precision of the order of one metre. The GNSS, which includes the Global Positioning System (GPS) of the United States of America, provides a signal that can serve that purpose and can also be used for a large range of other applications with economic benefits for the user.

3. The present report concerns the regional workshop, held in Kuala Lumpur from 20 to 24 August 2001, the first in a series being co-sponsored by the United Nations Programme on Space Applications and the Government of the United States of America. The workshop was organized in cooperation with the Government of Malaysia for the benefit of developing countries of the region of Asia and the Pacific. It was hosted by the Department of Survey and Mapping Malaysia, Ministry of Land and Cooperative Development.

4. The workshop focused on specific applications of the use of existing GNSS and their augmentations to further global environment objectives and enhance sustainable development programmes and to deepen the understanding of those applications in developing countries. Such global systems include the GPS of the United States and the Global Navigation Satellite System (GLONASS) of the Russian Federation. Applications include monitoring of the environment, precision agriculture, surveying and mapping, resource conservation, disaster management, transportation and timing and others.

5. The objectives of the workshop were (a) to bring the benefits of the availability and use of GNSS signals to the awareness of decision makers and technical personnel from potential user institutions as well as to service providers in the private sector, in particular in developing countries; and (b) to identify actions that could be taken and partnerships to be established by potential users. The workshop was also intended to increase the awareness of participants of the intrinsic value of GNSS signals in a sustainable development context and to motivate them to make use of GNSS in their own work. A direct result would be an expanded user base, which would be likely to include a network of experienced and beginner users from governmental and academic institutions as well as from the private sector.

6. In order to reach those objectives, the applications of the GNSS were reviewed, with special emphasis on (a) the current status and modernization policy of GPS (United States); the current status and future development of GLONASS (Russian Federation); (b) existing and future potential applications of those systems for sustainable development and protection of the environment of interest for countries in the region; and (c) promotion of regional and international cooperation.

B. Programme

7. At the opening of the workshop keynote addresses were given by the Director of the Office for Outer Space Affairs and Kasitan Gaddam, Minister of Land and Cooperative Development of Malaysia. The programme was divided into eight sessions: (a) existing and future GNSS systems and their applications; (b) GNSS for land management; (c) national programmes in the region; (d) disaster preparedness and environmental monitoring;

(e) conservation of resources; (f) precision agriculture; (g) surveying and mapping; and (h) GPS for timing and transportation. Country reports from countries of the region were also delivered. The workshop ended with a session on observations and recommendations.

C. Attendance

8. Participants at the workshop came from the following countries: Australia, Austria, Bangladesh, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Pakistan, Republic of Korea, Russian Federation, Singapore, Sri Lanka, Tonga, Turkey, Tuvalu, Viet Nam, United Kingdom of Great Britain and Northern Ireland, United States and Uzbekistan. The International Maritime Organization (IMO) and the Office for Outer Space Affairs were also represented.

9. Funds allocated by the United Nations and the United States were used to defray the costs of air travel and daily subsistence allowance of 27 participants from 18 countries and the Office for Outer Space Affairs. The Government of Malaysia, through its Department of Survey and Mapping Malaysia, Ministry of Land and Cooperative Development, provided board for all United Nations-sponsored participants. The programme for the workshop was developed by the Office for Outer Space Affairs and the State Department of the United States in cooperation with the Department of Survey and Mapping Malaysia.

II. Observations and recommendations

10. Electronic versions of all the presentations and country reports submitted, as well as observations/findings (which contains a summary of the presentations) and recommendations, are located on the web site of the Department of Survey and Mapping Malaysia at the following address: http://www.jupem.gov.my/gnss.htm (The full version of the observations and findings of the workshop can be found under the heading "Summary GNSS"; presentations are located under "Paper GNSS"; and country reports appear under "Speech GNSS".)

11. The recommendations of the workshop are summarized below.

A. Existing and future GNSS systems and their applications

12. The workshop recommended:

(a) Implementation of the recommendations of UNISPACE III in order to facilitate usage of GNSS (GPS, GLONASS) technology applications for the development of Asian and Pacific countries;

(b) Reduction of the potential to restrict modernization of GPS;

(c) Maintenance and modernization of GPS/GLONASS as a part of core GNSS;

(d) Establishment of channels of communication among GNSS national points of contact in order to promote future discussion;

(e) Seeking international support to further mutual interests as regards GPS and a modernized and enhanced GLONASS;

(f) Development of regional consensus on the frequency spectrum to ensure implementation to modernize GPS and GLONASS;

(g) Obtaining users' feedback as regards new GPS and GLONASS systems;

(h) Maintenance of a free signal from GNSS on a non-discriminatory basis;

(i) Increase in value added services;

(j) Continuing discussion to achieve a target of interoperable capability between GPS/GLONASS and Galileo.

B. Overview of the current and expected GNSS applications market

13. The workshop recommended:

(a) Evaluation of the impact of selected availability mode turn-off on consumer use;

(b) Renewal of old data recorded when selected availability was turned on;

(c) Taking advantage of the growing user community and of emerging applications;

(d) Obtaining more information about possible cooperation with the National Aeronautics and Space Administration (NASA) of the United States.

14. It also recommended that:

(a) Government and private enterprises work together to determine the boundaries for the provision of differential GPS (DGPS) services. At present there is an effective market where user needs are being met on a commercial basis. New technology is being developed and provided to satisfy user demands on a competitive basis. Developments by private companies are an important source of industry innovation;

(b) Many enhancements be made to real-time kinematic technology, such as:

(i) Ergonomic improvements in equipment;

(ii) On-the-fly initialization;

(iii) Reduction in time-to-initialize and increased initialization reliability;

(iv) Low-latency positioning;

(v) Moving baseline real-time kinematic technology.

C. GNSS for land management

15. The workshop recommended that:

(a) Systematic techniques and procedures be designed to help surveyors in Viet Nam to overcome difficulties in understanding the use of GPS;

(b) In order to extend the use of GNSS in GIS in India, the following be done:

(i) Digitization of existing paper map design;

(ii) Establishment of GPS-based control points;

(iii) Establish precisely located control points;

(iv) Design of a rectangular grid coordinate system;

(v) Transposition of existing triangular stations and boundary pillars to the new coordinate system;

(vi) Use of kinematic GPS to create digital records adopting the new coordinate system;

(c) The GIS community should develop coherent arguments to persuade Governments of the key role of GIS as a basis for electronic government (governing by electronic means).

D. National programmes in the region

16. The workshop recommended that:

(a) The Indian Satellite-Based Augmentation System (SBAS), almost operational by the end of 2005, be:

(i) A seamless navigation system, international in nature and with the same standards as the wide-area augmentation system (WAAS), the European Geostationary Navigation Overlay Service and the Multifunctional Transport Satellite Satellite-Based Augmentation System (MSAS);

(ii) A part of the evolving GNSS;

(iii) An active participant in the interoperability group of which the Federal Aviation Administration, European Tripartite Group and MSAS are members;

(b) SBAS may need European assistance for early trials through the navigational payload on INMARSAT-III for the Indian Ocean region. However, it is planned to put a navigational payload in one or two Indian geostationary communication satellites (of the GSAT/INSAT series) for dedicated use by the civil aviation community;

(c) Governments (by active participation through the establishment of steering committees):

(i) Establish a national plan on GNSS;

(ii) Establish user support groups;

(iii) Set up an augmentation infrastructure for the system;

(iv) Remove tax from GNSS-related products;

(v) Provide long-term protection of the GNSS/radio navigation system spectrum;

(vi) Maintain close contact with other countries in the development of GNSS technology for application in survey, mapping and other fields such as geological survey, marine navigation and boundary demarcation.

E. Disaster preparedness and environmental monitoring

17. The workshop recommended that:

(a) Disasters be minimized or even prevented by connecting all national safety management systems by means of an information network;

(b) An integrated system incorporating the use of GIS and GPS technologies for systematic efforts to cope with disasters efficiently and to minimize the loss of lives be established;

(c) The importance of using GIS and GPS for the implementation of national disaster management systems be recognized;

(d) GPS be used as an effective tool for real-time monitoring of bridge motion;

(e) GPS be used to improve the reliability and safety of transport services;

(f) Applications of GPS and/or the Indonesian INSAR satellite be further studied to monitor landslide mitigation in Indonesia. (Landslides are one of the major geohazards continuously affecting the Indonesian population, especially in the rainy season.);

(g) The methodology of "no net rotation" constraint be used in the construction of the international terrestrial reference frame.

F. Conservation of resources

18. The workshop recommended that:

(a) Scientific research be conducted in several areas, including for the study of height datum unification of sea-level using GPS installed on buoys and sea vessels;

(b) GPS be used for:

(i) Classification of forest cover;

(ii) Assessment of the spatial variability of gaps and gap sizes in forests.

G. Precision agriculture

19. In the area of GNSS applications to precision agriculture, the workshop recommended:

(a) The development of information requirements for the following technologies and techniques:

(i) GPS;

(ii) DGPS;

(iii) Real-time DGPS services;

(iv) DGPS augmentation systems;

(v) Mobile mapping;

(vi) Application software and GIS;

(vii) Hand-held personal computers;

(b) Increased efficiency and reduction of the impact on the environment from agrochemical inputs in agricultural production through site-specific management using GPS, GIS, sensor systems and variable-rate technology;

(c) Improvement in user information technology capability in positioning systems, with emphasis on high accuracy in mapping at low cost;

(d) Provision of more reliable real-time navigation signals and systems for variable-rate application;

(e) Establishment of a worldwide information exchange centre/network related to precision agriculture.

H. Surveying and mapping

20. The workshop recommended that:

(a) The same re-observation and re-adjustment be performed for the network of scientific instruments for east Malaysia;

(b) Countries intending to use GNSS in the future be aware of the development of GNSS infrastructure, such as the modernization of GPS and the development of the Galileo and other systems. New

GNSS infrastucture should overcome some of the current limitations, thus giving more accurate results in a shorter time and at lower cost, and covering larger areas.

I. GPS for timing and transportation

21. The workshop recommended that:

(a) A GNSS forum be established by IMO on operational requirements, performance standards and institutional arrangements;

(b) User requirements in DGPS for navigation be reviewed;

(c) Standards and practices related to GNSS be constantly developed to meet the needs of the maritime industry;

(d) Time compatibility between the GPS and Galileo systems be addressed to ensure inter-operability. Studies and simulations needed to be conducted in that regard;

(e) The potential for local contributions to the Aeronautical Navigation Satellite System in Indonesia be taken into account in future activities related to its utilization and development;

(f) The current status of the WAAS and the local area augmentation system (LAAS) initial operational capability for the certified WAAS signal should be taken into account. The signal is expected to be introduced in December 2003. LAAS Category I landing should be operational in 2003.

III. Summary of country reports

A. Bangladesh

22. Application of GPS has already proved to be very effective in certain development activities in Bangladesh. The use of GPS technology effectively started in a number of institutions in the early 1990s. The Bangladesh Space Research and Remote Sensing Organization is using GPS for collecting control points for geo-referencing remotely sensed data. The other regular application of GPS by the Organization is to locate the position of the features in the field for collecting ground truth data. Such data were also used during the devastating floods of 1998 to identify and delineate flood-affected areas, which helped the concerned authorities considerably in taking appropriate and timely measures. The Local Government Engineering Department has produced Upazilla and Pourashava base maps using GPS. The Department has been carrying out an extensive field survey using GPS to develop a road network database that will subsequently be used in planning physical structures. The road network database (mainly for rural areas) has already been completed for more than 50 per cent of the country.

1. Survey of Bangladesh

23. In 1992, under the auspices of the Japan International Cooperation Agency, a geodetic survey was carried out throughout the country by the Survey of Bangladesh. Extensive information was collected for the study using DGPS all over the country.

2. Geological Survey of Bangladesh

24. The Geological Survey of Bangladesh has been a user of GPS since 1995. In 1997-1998, the technology was used for drilling mines in the country. In recent years, it has been used to identify locations of tube wells in arsenic-affected areas throughout the country. A study on coastal dynamics is expected to be undertaken by the Government of Bangladesh in the near future where identification of flood plain elevation will be necessary to assess those dynamics.

3. Bangladesh Water Development Board

25. The Bangladesh Water Development Board uses GPS in flood monitoring, especially in determining location-based flood depth and its extension during flood time.

4. Environment and Geographic Information System

26. The Environment and Geographic Information System uses GPS for location information specifically for identifying water sector features in different parts of the country.

27. In order to improve the usage of GNSS technologies in Bangladesh, three main points may be considered. Firstly, GNSS is not a well known technology in Bangladesh. It is therefore essential to

create awareness of the usefulness of the technology among potential users. Such awareness can be created through the arrangement of workshops/seminars on the applications of GPS/GNSS. Secondly, it is essential to define the potential field(s) of application of GNSS in the Bangladeshi context. This can be done through a detailed survey of the relevant ongoing activities of the Government and non-governmental organizations. Thirdly, in Bangladesh, as an economically developing country, users should be given an opportunity to access the technology at an affordable price. Therefore, the cost of the GNSS receiving systems should be reduced.

B. Cambodia

28. GPS is widely used in Cambodia by various governmental and non-governmental organizations and a number of foreign and local private companies. The Cambodian organizations that are using GPS data are the State Secretariat of Civil Aviation, the Ministry of Metrology, the Ministry of Transportation, the Ministry of Land Management, Urban Planning and Construction, the National Committee for the Mekong River and the National Committee for Border Affairs. Cambodia needs much international support and technical assistance in the field of training and human resources.

C. Maldives

29. The following recommendations are offered for the GPS navigation system:

(a) Increase in the memory of GPS receivers. Each atoll in Maldives has almost 1,000 shallow patches and coral reefs that are very hazardous to navigation, especially at night. Additional memory would thus enable users to store those shallow patches in the GPS equipment memory;

(b) Increased zoom capability of charts;

(c) Improved loading capability. For some GPS receivers it takes a long time to load data, especially during adverse weather conditions;

(d) Large screens are needed to show details of charts used for navigation on GPS receivers;

(e) Access to DGPS transmission frequencies is needed in the region.

D. Pakistan

30. In Pakistan, GNSS technology is being used by: the Survey of Pakistan, for its cartographic applications, the City Police Liaison Committee, for tracking and geo-positioning of vehicles in cases of theft and other crimes, and the Hydrography Department, for marine survey and generation of hydrographic charts for navigational purposes.

31. DGPS data are an important component in the balloon soundings programme of the Space and Upper Atmosphere Research Commission for the determination of vertical wind profile and wind weighting factors for carrying out rocket experiments. In the Commission's satellite remote sensing and GIS application activities, this technology is being routinely used to obtain ground control points, geographical coordinates and elevation data for geometric correction and ortho-rectification of remote sensing images. With the availability of high-resolution satellite data of one metre and less than one metre, the use of GPS has become even more important. The technology now enables generation of digital elevation models and digital terrain models at very fine contour intervals.

E. Sri Lanka

32. The importation of GPS receivers was not regulated by the Telecommunications Regulatory Commission of Sri Lanka until 2000. This allowed the public and companies to import and use GPS receivers for various purposes. The applications of GPS in Sri Lanka may thus be used in several governmental and non-governmental institutions for different purposes. For example, each month more than 300 fully loaded super-tankers pass by the southern coast of Sri Lanka en route from the Middle East to the Far East. They use DGPS technology for safe navigation. There is an urgent need to upgrade existing navigation facilities. DGPS technology is also being used for hydrographic surveying and the fishing industry. Most deep-sea fishing vessels are equipped with GPS systems. Furthermore, the technology should also be used extensively in maritime research by the National Aquatic Resources Research and Development Agency, in the prevention of marine pollution by the Marine Pollution Prevention Authority and for prospecting in

oil and minerals by the Government of Sri Lanka, as there is tremendous potential.

F. Tonga

33. Aeroplanes and most of the maritime vessels operating in Tonga are equipped with GPS receivers. Most fishing boats are also equipped with GPS receivers, improving conditions for finding fishing areas. GPS is also used in the location and positioning of marine navigational aids in very remote areas. During the cyclone season the technology is used to locate cyclones and also to determine from satellite images the size of the cyclone.

G. Turkey

34. In the case of Turkey, three continent-sized plates are moving across the Earth's surface and interact along their edges. GPS technology, along with other technologies, was able to monitor crust deformation in and around the Sea of Marmara for seven years with high accuracy. The displacement of two rigid blocks along the North Anatolian fault was found to be about 2.5 centimetres per year.

35. There are a number of governmental bodies using GPS technology for marine and atmospheric data processing, land use and cadastral maps, forest fire monitoring and so on. Among them are the Istanbul Technical University, the Middle East Technical University, the Atomic Energy Council of Turkey, the Ministry of Environment and Forestry, a number of private digital geo-processing companies and others.

H. Uzbekistan

36. GPS receivers are used by organizations of the State Committee "UzGeoCadastr", the Surveying and Mapping Agency in Uzbekistan. They carry out geodesic-cadastral work in some parts of Uzbekistan's territory from 1996 using Navstar GPS receivers manufactured by the Ashtech (United States) and Leica (Switzerland) companies. The principal tasks are as follows: (a) creation, upgrading and maintenance of Uzbekistan's state geodesic network; (b) precise measurement of surveying and geodesic network coordinates; (c) planning work for construction of buildings; and (d) mapping using aerial and space images.

Notes

[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III)*, chap. I, resolution 1, part I, para. 1 (e) (ii) and chap. II, para. 409 (d) (i).