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**Committee on the Peaceful Uses of Outer Space**

# Report on the United Nations Expert Meeting on the International Space Station Benefits for Humanity

**(Vienna, 11-12 June 2012)**

## I. Introduction

1. The United Nations Expert Meeting on the International Space Station Benefits for Humanity was held in Vienna from 11 to 12 June 2012. The Meeting was part of the Human Space Technology Initiative, a new initiative carried out under the framework of the United Nations Programme on Space Applications (see www.oosa.unvienna.org/oosa/en/SAP/hsti/index.html).

2. The Meeting focused on facilitating dialogue to extend the benefits of the International Space Station (ISS) to humanity. The Meeting was designed to stimulate discussions and to facilitate the exchange of ideas on potential synergies between the ISS partner agencies and United Nations organizations in the areas of Earth observation and disaster response, health and education. The expected outcome of the Meeting was achieved as connections were identified between existing ISS activities and the needs of United Nations organizations in these areas.

3. The Meeting was organized by the Office for Outer Space Affairs of the Secretariat as part of the activities of the United Nations Programme on Space Applications in 2012. The Meeting was co-organized by the partner agencies of the ISS programme, namely, the Canadian Space Agency (CSA), the European Space Agency (ESA), the Japan Aerospace Exploration Agency (JAXA), the National Aeronautics and Space Administration (NASA) of the United States of America, and the Russian Federal Space Agency (Roscosmos).

4. The present report describes the background, objectives and programme of the Meeting; provides a summary of activities of the participating ISS partner agencies and United Nations organizations; and contains the collaboration concepts and observations made by participants. The report has been prepared pursuant to General Assembly resolution 66/71.

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## A. Background and objectives

5. From the beginning, outer space has caught the imagination of humanity. With technological development, travelling into space finally became a reality. On 12 April 1961, Yuri Gagarin became the first human being to venture into space, opening up a new era of human activity that was no longer limited to the surface or atmosphere of the Earth. Within a decade, the first human beings set foot on the surface of the Moon. In the 1980s, the Union of Soviet Socialist Republics launched the Mir space station and operated it for more than a decade.

6. Through the combined efforts of its five partner agencies, ISS was developed, constructed and launched to further peaceful cooperation in space, and has been continuously crewed for over 11 years.

7. The Third United Nations Conference on the Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999, recognized that large human space exploration missions exceeded the capacity of a single country and that cooperation should be privileged in that area. ISS was cited as an example of that new paradigm made possible by the end of the cold war.[1] UNISPACE III recommended the development of future space science programmes, in particular through international cooperation and the encouragement of access to ISS by countries that had never participated in that endeavour. It also advocated the worldwide dissemination of information about research activities aboard ISS.[2]

8. In 2010, the Human Space Technology Initiative was launched under the framework of the United Nations Programme on Space Applications, with the aim of raising awareness of the benefits of human space technology, promoting international cooperation in activities related to human space flight and space exploration and supporting capacity-building in microgravity research and education.

9. As part of the initiative, the Office for Outer Space Affairs organized, in cooperation with the five ISS partner agencies, a one-day outreach seminar on ISS in Vienna in February 2011. At the seminar, the status of educational and research activities, and the process of participating in research aboard ISS was presented. The seminar established that the Human Space Technology Initiative could be a meaningful mechanism for creating awareness about the potential of ISS research and educational activities (A/AC.105/2011/CRP.13).

10. The first United Nations/Malaysia Expert Meeting on Human Space Technology was held in Putrajaya, Malaysia, from 14 to 18 November 2011. The Meeting aimed to share with participating experts from around the world information about the latest activities on board ISS, multiple space programmes at national, regional, and international levels and microgravity research and educational activities. The Meeting also aimed to define potential activities of the Human Space Technology Initiative, in particular, capacity-building in the areas of microgravity research and education in developing countries. The Meeting agreed

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[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. II, para. 388.

[2] Ibid., paras. 389, 390, 401 and 402.

on 10 recommendations for future activities of the Human Space Technology Initiative (A/AC.105/1017).

11. The United Nations Expert Meeting on International Space Station Benefits for Humanity was organized to further discuss the identification of potential synergies between existing ISS activities and the needs of United Nations organizations, and particularly focused on the results of ISS research and technology applications. The Meeting had the following primary objectives:

(a) To provide an opportunity for the ISS partner agencies and United Nations organizations to discuss ways to extend the benefits of ISS research accomplishments in the areas of Earth observation and disaster response, health and education;

(b) To leverage the expertise of United Nations organizations to identify specific opportunities to extend the benefits of ISS to humanity;

(c) To leverage the network and current activities of the United Nations organizations to reach more people and countries with the benefits of human space technology.

## B. Attendance and financial support

12. Representatives of the ISS partner agencies, which included CSA, ESA, JAXA and NASA, and the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), the World Health Organization (WHO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Office for Outer Space Affairs participated in the Meeting.

13. Experts from around the world were also selected on the basis of their work experience in the fields of Earth observation and disaster response, health and education. They contributed to the discussions during the Meeting.

14. The Meeting was attended by 38 professionals from governmental institutions, universities and other academic entities in the following 18 countries: Albania, Austria, Bangladesh, Canada, China, Czech Republic, Ecuador, Germany, Ghana, Italy, Japan, Mexico, Netherlands, Nigeria, Pakistan, Saudi Arabia, Thailand and United States of America, and by professionals of the United Nations entities referred to in paragraph 12 above.

15. Funds allocated by the United Nations were used to defray the cost of air travel, daily subsistence allowance and accommodation for 13 participants.

## C. Programme

16. The programme of the Meeting was developed by the Office for Outer Space Affairs in cooperation with the programme committee. The programme committee consisted of members from the five ISS partner agencies and the Office for Outer Space Affairs.

17. In order to facilitate discussions on the various subjects, 14 concept ideas were prepared in the form of concept notes prior to the Meeting. Six concepts notes were

for Earth observation and disaster response, two were for health and six were for education. A subset of these concepts was identified as appropriate for information exchange consistent with the objectives of the Meeting.

18. The Meeting programme consisted of eight technical presentation sessions and one concluding session. The detailed programme and the documentation relating to the presentations made at the Meeting are available on the website of the Office for Outer Space Affairs (www.oosa.unvienna.org/oosa/en/SAP/hsti/expert-meeting-2012.html).

19. The eight technical presentation sessions were divided into five categories: activities of ISS; activities of United Nations organizations; Earth observation and disaster response; health; and education. The Meeting concluded with an outlook session during which participants examined the concepts presented in the technical presentation sessions and provided observations on each concept.

# II. Activities of the International Space Station and United Nations organizations

20. It was the first time that the ISS partner agencies and United Nations organizations had discussed how to utilize ISS for the benefit of humanity. Five sessions were organized during which each organization had the opportunity to share information about its activities.

## A. Activities of the International Space Station

21. It was noted that ISS was the result of the combined efforts of 15 nations, constituting a good example of an unprecedented multinational long-term partnership. With its size of approximately 110 metres in length and 74 metres in width, and with a mass of over 400 tons, ISS orbits the Earth at an altitude of 400 kilometres, ISS accommodated a crew of six and has various research facilities. Not only did it provide a unique platform in space for a variety of research fields, such as life science, biology and biotechnology, physical and material sciences, human research and Earth and space sciences, ISS had also demonstrated the viability of certain technologies, including robotic refuelling in space and multi-body manoeuvring in orbit, and had carried out various educational activities for young generations.

22. It was noted that each ISS partner agency conducted scientific and technical programmes on board ISS depending on its research focus. CSA is particularly involved in human research to make space safer for humans, and in complementing knowledge acquired on Earth and accelerating relevant applications for daily life to improve health on Earth. CSA and its collaborative industries had developed the robotic arm (Canadarm2), as well as the Special Purpose Dexterous Manipulator (Dextre), and had contributed to the advancement of medical operations on the ground.

23. It was noted that ESA conducted its activities under the European Programme for Life and Physical Sciences based on strong international cooperation and by making use of Columbus and other ISS partner laboratories.

Approximately 200 ESA research projects had been conducted in the following areas: biology and biotechnology, human research, physical science, Earth and space science, technology demonstrations and educational/outreach activities.

24. JAXA promoted research work through its on-board facility Kibo (which meant "hope" in Japanese). According to its plan for the period until 2020, JAXA was targeting the areas of life science, space medicine and physical and chemical sciences. JAXA was to select some large-scale research projects in highly prioritized research areas in 2012 and would invite some foreign research teams to participate in those projects through international peer reviews. The representative of JAXA also referred to its collaborative scientific and educational activities, such as protein crystallization research and the "Space Seeds" project, as ways to utilize ISS together with other Asian countries.

25. NASA highlighted the research work that had been pursued by the ISS partnership, particularly in the areas of human health, telemedicine, education and Earth observation. Vaccine development research, water filtration technology, natural and man-made disaster observation and educational programmes for future scientists and engineers are just some examples of research benefits. The booklet, entitled "International Space Station Benefits for Humanity", developed collaboratively by the ISS partner agencies, listed 28 research activities that had had, and would continue to have, an impact on life on Earth.

## B. Activities of the United Nations organizations

26. Representatives of the Office for Outer Space Affairs, WMO, UNEP, WHO and UNESCO outlined their activities and stressed the importance of space technology as an innovative solution for sustainable development.

27. It was noted that the Office for Outer Space Affairs was responsible for the Programme on Space Applications and the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). The Programme on Space Applications focused on promoting space science and technology around the world and had implemented three initiatives in the areas of basic space science, basic space technology and human space technology. As part of the Human Space Technology Initiative science activities, the Office for Outer Space Affairs was currently working on a zero-gravity instrument project with the aim of expanding hands-on learning opportunities in microgravity science at schools.

28. The representative of WMO emphasized that space-based Earth observation was fundamental to weather and climate monitoring and forecasting. It was stressed that weather applications were critical to public safety and socioeconomic benefits. The representative highlighted the WMO aim of promoting the widespread availability and utilization of satellite data and products for weather, climate, and water monitoring and measuring. As upcoming technologies and capabilities could offer a considerable number of new opportunities, it was emphasized that global coordination should be achieved in order to optimize the use of all available resources. WMO also proposed an idea calling for an absolute radiometric calibration reference payload to be flown into space. The instrument, aimed at providing traceability according to international standards, which was currently

missing from all Earth observation missions, could enhance the quality of information derived from space for a wide range of Earth observation.

29. The representative of UNEP noted that the central tasks of the Programme were to monitor the global environment and to bring emerging issues and potential solutions to the attention of Governments and the international community to enable action to be taken. UNEP had been analysing the state of the global environment, providing early warning information and assessing environmental trends at the regional and global levels. It had implemented global programmes in numerous regions by initiating, coordinating and catalysing regional and subregional cooperation.

30. It was noted that WHO led the world on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends. Producing health guidelines and standards, WHO had a large repertoire of global normative work. The representative of WHO referred to the potential of eHealth as a cost-effective and secure use of information and communication technology, which included a large variety of space-based assets.

31. The representative of UNESCO highlighted the activities of that organization in supporting World Heritage sites as an example of space technology applications for humanity. There were more than 900 World Heritage sites around the world. Through its global partnerships with more than 60 space partners located in 33 countries, UNESCO was dedicated to demonstrating and promoting space applications for decision makers. Those activities included “Space 4 Decision”, which assessed the state of conservation of World Heritage tropical rainforest sites called “UNESCO Watch” and created an image atlas of endangered World Heritage sites on its “in danger” list.

## C. Earth observation and disaster response

32. It was noted that ISS offered a unique vantage point for observing the Earth’s ecosystems, which covered about 85 per cent of the Earth’s surface and 95 per cent of the Earth’s population, with manually operated and automated Earth observation equipment. Unlike many of the traditional Earth observation platforms, ISS had an inclined equatorial orbit that was non-Sun-synchronous, meaning the station passed over locations on Earth with a geographical latitude between 52 degrees North and 52 degrees South at different times of the day and under varying illumination conditions.

33. It was noted that NASA had a variety of Earth observation payloads attached to ISS. Crew Earth Observations had collected imagery from various ground, coastal and atmospheric targets, including dynamic events and disasters, in support of collaborative science, education, public outreach and disaster response. The ISS Program Science Forum Earth Observation Working Group was focusing on the coordination of ISS remote-sensing activities for disaster response and humanitarian aid.

34. It was noted that the Window Observation Research Facility was positioned over the United States Destiny Laboratory and had supported multiple instruments

at the same time, as well as rapid instrument exchange. Systems managed by NASA, such as the ISS Agricultural Camera, the Hyperspectral Imager for the Coastal Ocean and the ISS SERVIR Environmental Research and Visualization System, were currently (or would shortly be) on board and operational on ISS. Individual science teams were managing the access to data collected by the various sensor systems.

35. It was noted that ESA utilized ISS for studies in the area of climate change. The Solar Monitoring Observatory was using three science instruments to provide detailed measurements of the Sun's spectral irradiance and could contribute to climate modelling of the Earth's environment. Other studies include bird migration tracking, where a multinational project for tracking small animals on a global scale used miniaturized tags that communicated with ISS receivers and transmitters. The goal of the research was to identify unknown migrations, the impact of climate change on animal migration and biodiversity, and the spread of animal-borne diseases.

36. It was noted that JAXA conducted atmospheric research and was monitoring the present conditions of ozone layer depletion, global warming and air pollution. A high-definition television camera was to be installed soon to deliver high-quality views of the Earth's surface, while a super sensitive high-definition camera would provide full-colour video capturing even in low-light conditions.

## D. Health

37. ISS and earthbound analogues provided unique possibilities to study the reaction of the human body to extreme environmental conditions. A space environment caused health-related problems and effects on the human body that could be linked to some age-related diseases suffered by the Earth's population. Studies had been conducted in a microgravity environment on balance disorders, cardiovascular deconditioning, decrease of bone mineralization and muscle disuse atrophy. Other research areas included studies of a closed, confined, and multicultural environment, the effects of cosmic radiation, which were linked to cancer risk, and the reduction of immune responses.

38. Medical systems developed for ISS crew members were also referred to as potentially contributing to improved health care on Earth. A training and remote guidance tool for portable ultrasound devices, which had been developed by NASA in cooperation with universities in the United States, allowed non-physician astronauts to rapidly diagnose and treat a wide variety of medical conditions.

39. The technology of robotic arms for the space shuttle and ISS had led to the world's first Magnetic Resonance Imaging compatible image-guided, computer-assisted device specifically designed for neurosurgery. This technology, which had been developed by Canada, was being used in hospitals worldwide. Other examples of benefits were telemedicine advancements, macromolecular crystallization and water recycling technology.

40. The representative of WHO emphasized that health required extensive data collection, information management and knowledge utilization at all levels and at all times. It was important to quickly convey qualified data and information to

people in relevant positions and fields. Satellite utilization by WHO included public health mapping, such as disease surveillance, epidemiology, water supply and delivery, poverty mapping and emergencies and disasters.

## E. Education

41. As a result of the long-term operation of ISS, a considerable number of students had benefited from educational projects utilizing ISS. Projects such as "Amateur radio on the International Space Station" and "Seeds in space" were cited as examples. In addition, ISS astronauts often supported educational activities by giving talks to schoolchildren or by carrying out educational demonstrations.

42. NASA conducted a science education activity called "Butterflies, spiders and plants in space", which demonstrated the effectiveness of using ISS as a platform for experiments centred around students, and education in science, technology, engineering and mathematics learning. During the experiments, the organisms' life cycles and behaviour in microgravity were recorded in still images and video that were available online globally, along with teachers' guides and other educational materials.

43. It was noted that CSA offered a variety of educational information, such as web-based pedagogical materials and materials on CD and DVD, plant growth experiments focusing on tomato seeds, and physical fitness activities called "Get fit for space". It had designed a project called AuroraMAX, the first project to simultaneously monitor the aurora borealis from Earth and ISS. The unique appeal of the northern lights involved the public.

44. Modular didactic materials created by ESA included ISS education kits, available in 12 languages, and movie materials covering basic space science, health and nutrition education and space robotics. ESA also provided online lessons for both primary and secondary students in 13 languages, as well as courses for university students and professors. Many of those activities were linked to comprehensive ISS on-orbit demonstrations performed by astronauts.

45. It was noted that "Uchu Renshi" (which meant "space poem chain" in Japanese) was one of the unique activities started by JAXA. It connected people, including crew members in space, by allowing them to think together about the universe, Earth and life itself, and created a linked verse. JAXA also conducted the zero-gravity flight experiment contest, which provided parabolic flights for students in Japan and other Asian countries, and plant seed experiments as part of international cooperation.

# III. Concepts and observations

46. Three sessions were organized to discuss how to extend the benefits of ISS to humanity. Concepts were presented and discussed in order to evaluate whether synergies existed and whether potential activities should be explored between the ISS partner agencies and United Nations organizations in the following areas: Earth observation and disaster response, health and education.

## A. Earth observation and disaster response

47. A concept called "Utilization of the ISS-collected imagery, photography archives and other data for sustainable development" was proposed to identify available photos, videos or other information collected on board ISS and other manned missions, in order to categorize them and create a centralized database. To benefit specific research on various scientific and technical themes, geo-referencing crew photography was considered an ideal approach. Time and budget constraints would be the major challenges in realizing that idea. All information about Crew Earth Observation photography was publicly available online for use by all interested parties worldwide. The representative of UNESCO suggested that its network of universities could be used to assist in geo-referencing Crew Earth Observation photography.

48. Additional concepts on Earth observation and disaster response were proposed, including "Evaluation of the effectiveness of ISS-based information in monitoring floods", proposed by the Bangladesh Space Research and Remote Sensing Organization, and "ISS-based information to enhance the monitoring of recurring climate-related phenomena and of environmental issues", proposed by the Office for Outer Space Affairs. ISS partners provided information on how existing public data archives could be used to address specific data requests and stated that online tutorials were available.

## B. Health

49. A concept called "Space-proven telemedicine device and services for underserved populations" was proposed by the Office for Outer Space Affairs and the Technical University of Munich to identify and transfer space-proven telemedicine applications on board ISS to be used on Earth to benefit underserved populations. Since different countries and groups might have different needs in telemedicine applications, it was important to start by identifying two or three target countries to reach the right groups and their actual needs. An initial two-day workshop would lay the groundwork for case studies of successful transfer projects, transfer candidates and general guidelines.

50. A concept called "Using portable ultrasound to enhance diagnostics in vulnerable populations based on ISS experiences" was presented by the Henry Ford Hospital in the United States and by the World Interactive Network Focused on Critical Ultrasound, and was based on research originally conducted for NASA. The aim of this concept is to train and guide non-specialist users on how to utilize the available training and the remote-guidance tool developed for ISS, in order to contribute to enhanced diagnostic and management procedures in underserved regions and their populations. The portable ultrasound device can be a commercial off-the-shelf product.

## C. Education

51. A concept called "Distribution of educational materials for microgravity science and human space technology" was proposed by the Office for Outer Space

Affairs to translate educational materials on microgravity science and human space technology into the official languages of the United Nations and distribute them via the United Nations network throughout the world. The ISS partner agencies had developed a considerable amount of educational materials on different subjects linked to microgravity research and human space technology. That concept could be combined with the proposal of UNESCO on educational activities with schools.

52. A concept called "Butterflies, spiders and plants in space: reaching a worldwide audience of students on ISS" was proposed by BioEd Online at the Baylor College of Medicine in the United States, and was based on their ISS education activities to provide learning experiences to spark students' enthusiasm, to build their skills related to science, technology, engineering and mathematics and to promote collaboration among students and teachers worldwide. Students had learned how gravity affects living organisms by observing space experiments conducted on ISS and by carrying out ground experiments. The existing educational materials for that concept could be distributed to more students around the world.

53. UNESCO proposed several concepts on outreach and education. "Educational activities with schools" would take advantage of the school network of UNESCO to distribute educational materials developed for ISS and other space missions. "Educational activities in universities" would use a network of universities to create user-friendly educational materials and distribute them worldwide. UNESCO also proposed to support student-led projects utilizing publicly available Earth observation data from ISS relevant to United Nations activities, such as site monitoring, as well as data on environmental and climate changes.

# IV. Conclusions

54. The United Nations Expert Meeting on the International Space Station Benefits for Humanity was held to facilitate dialogue between the ISS partner agencies and the United Nations organizations to extend the benefits of ISS to humanity.

55. Discussions were carried out on the potential benefits of ISS in the areas of Earth observation and disaster response, health and education. Several concepts were presented and discussed by the participants. It was observed that further assessment of those concepts by the interested parties would be needed prior to further exploration of potential activities.

56. More than 50 years have passed since the first human ventured into space. A new era of international cooperation has arrived with the construction of ISS and it has brought numerous scientific and technical advancements. By facilitating the exchange of knowledge that the ISS partners have gained with the United Nations organizations, the Human Space Technology Initiative further strives to maximize the benefits of human space technology for all people on Earth.