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Report on the United Nations/Islamic Republic of Iran Regional Workshop on the Use of Space Technology for Human Health Improvement

(Tehran, 23-26 October 2011)

I. Introduction

1. The prime objectives of the United Nations/Islamic Republic of Iran Regional Workshop on the Use of Space Technology for Human Health Improvement held in Tehran from 23 to 26 October 2011 were to promote awareness of the use of space technology with regard to health care and to review the benefits of applications such as tele-health and telemedicine, mobile health, tele-epidemiology and distance learning. The capabilities of satellite-based technology for the above applications have not been fully disseminated to the health-care providers and agencies that could be using them. The Workshop contributed to addressing that.

2. The present report describes the background, objectives and programme of the Workshop and contains recommendations made by the Workshop participants. The report has been prepared pursuant to General Assembly resolution 64/86.

A. Background and objectives

3. Public health is the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, public and private organizations, communities and individuals. It is concerned with threats to the overall health of a community based on analyses of populations ranging from a handful of people to all the inhabitants of several continents (for instance, in the case of a pandemic). Public health is typically divided into epidemiology, biostatistics and health services. Environmental, social, behavioural and occupational health are important subfields of those categories.

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4. The focus of a public health intervention is to prevent rather than treat a disease and it works through the surveillance of cases and the promotion of healthy behaviours. However, in many cases, treating a disease may be vital to preventing it in other people, such as during an outbreak of an infectious disease.

5. With the increasing use of space technology services, tele-health and telemedicine are receiving worldwide attention. They consist of computer and telecommunications (including satellite-based communications) technologies that allow medical experts to be in contact with patients in remote and rural areas, thus avoiding the relocation of patients, which is both costly and dangerous to their health.

6. Until recently, the most important applications of tele-health and telemedicine have been in ambulances and on ships, where the speed of diagnosis is critical. Tele-health and telemedicine also allow the vital signs of patients to be monitored remotely and allow treatment requirements to be communicated in advance to hospitals.

7. Terrestrial communications may be damaged as a result of earthquakes, fires or flooding. In such situations, satellites remain the only reliable means of direct connection to the disaster area for communication regarding diagnosis, patient treatment and activity coordination. In addition, satellite links can be established in short periods of time.

8. There are about 1,400 communicable diseases, and half of the world's population live in endemic areas. Public health and epidemiology, in particular, have been widely discussed in the past few years, mainly as a result of the severe acute respiratory syndrome (SARS) crisis and the threat of pandemic influenza. Despite advances in modern medicine, diseases like malaria, dengue fever and even the plague still afflict millions of people each year, crippling some and proving fatal to others. Many diseases are transmitted by mosquitoes, which can lead to epidemics among people or animals. Malaria alone infects up to 500 million persons each year, killing almost 1 million.

9. Advances in satellite remote sensing, global positioning, geographic information systems and computer processing now make it easier to integrate ecological, environmental and other data for the purpose of developing predictive models that can be used in disease surveillance and control activities.

10. Landscape epidemiology is a relatively new interdisciplinary approach that involves the characterization of eco-geographical areas where diseases develop. It can be understood as part of a second-generation application of remotely sensed data, where the target cannot be seen directly with satellite images. It is a holistic approach that takes into account relationships and interactions between the different elements of ecosystems and assumes that the biological dynamics of both the host and vector population are driven by landscape elements such as temperature and vegetation.

B. Programme

11. With regard to tele-health and telemedicine, the programme of the Workshop included: (a) satellite-based television and radio broadcasting, an inexpensive

platform for delivering health-care education to distant locations; (b) satellite-based mobile communications, the most promising means for reaching underserved and isolated areas; (c) satellite-based delivery in emergency situations; (d) satellite-based services for mobile objects on land, at sea and in the air; and (e) satellite-based remote sensing and satellite positioning and location as tools for tele-epidemiology applications.

C. Attendance

12. A total of 139 participants from the following 11 countries attended the Workshop: Belarus, Bhutan, Germany, India, Iran (Islamic Republic of), Lao People's Democratic Republic, Myanmar, Pakistan, Philippines, Republic of Korea and Spain. Representatives of the United Nations Resident Coordinator in the Islamic Republic of Iran, the Office for Outer Space Affairs of the Secretariat, the World Health Organization (WHO) and the Asia-Pacific Space Cooperation Organization also participated.

13. Funds allocated by the United Nations and the Government of the Islamic Republic of Iran through the Iranian Space Agency were used to defray the cost of air travel, daily subsistence and accommodation for 12 participants. The co-sponsors also provided funds for the organization of and facilities for the Workshop, and transportation for participants.

II. Summary of technical presentations

A. Tele-health and telemedicine

14. It was noted that WHO described telemedicine as the delivery of health-care services, where distance was a critical factor, by health-care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health-care providers, all in the interest of advancing the health of individuals and their communities.

15. The goal of telemedicine was to improve health outcomes and provide clinical support by overcoming geographical barriers and connecting users who were not in the same location. Telemedicine involved the use of various types of information and communications technology. There were two basic types of telemedicine applications, based on the timing of the information transmitted: (a) interaction between the individuals involved in real time (doctor to doctor and doctor to patient); and (b) store-and-forward data exchange.

16. In developed countries, the majority of telemedicine services focused on diagnosis and clinical management. In developing countries and countries with limited infrastructure, telemedicine applications were primarily used to link health-care providers in local hospitals with specialists in referral and tertiary hospitals.

17. WHO had carried out a survey that showed that: (a) 30 per cent of responding countries had a national agency for the promotion and development of telemedicine;

(b) 50 per cent of responding countries reported that scientific institutions were involved in the development of telemedicine; (c) 20 per cent of responding countries reported having undertaken an evaluation or review on the use of telemedicine in their country since 2006; and (d) teleradiology had the highest rate (33 per cent) of established service provision. Countries in Africa, the Eastern Mediterranean and South-East Asia had the lowest rates of national policy on telemedicine.

18. The most prevalent barrier to the establishment of telemedicine services was the perception that the cost of deployment was too high. In developing countries, in addition to high costs, the infrastructure was underdeveloped and there was a lack of technical expertise. In developed countries, there were legal issues related to privacy and confidentiality, competing health system priorities and a perceived lack of demand.

19. The Ministry of Health and Medical Education of the Islamic Republic of Iran, through its partnership with WHO, had upgraded its web-based influenza surveillance system. The system had been piloted at Shahid Beheshti University and would be used in at least 10 districts of Tehran. In cooperation with WHO, the Ministry had developed a web-based vaccination supplies stock management application to connect the central vaccine store to regional, provincial and district stores (435 vaccine stores were currently connected to the application).

20. The Asia-Pacific Space Cooperation Organization was an intergovernmental organization operating as a not-for-profit independent body with full international legal status. Its objectives were: (a) to promote and strengthen the development of collaborative space programmes among its member States by establishing a basis for cooperation in the peaceful applications of space science and technology; (b) to take effective action to assist member States in areas such as space technology research, development, applications and training by elaborating and implementing space development policies; (c) to promote cooperation and joint development and to share achievements among member States in space technology and its applications, as well as in space science research, by tapping the cooperative potential of the region; (d) to enhance cooperation among relevant enterprises and institutions of member States; (e) to promote the industrialization of space technology and its applications; and (f) to contribute to the peaceful uses of outer space through international cooperation on space technology and its applications.

21. The implementation of tele-health applications needed to be prioritized because it was unlikely that the resources would be available to implement all of them at the same time. Health-care authorities needed to make a decision regarding which services to implement first, taking into account: (a) the proportional difference between expenditures and savings over a five-year period; (b) the evidence of the impact of telemedicine on travel patterns from remote and rural areas to metropolitan areas; and (c) how easy it would be to implement each particular application.

22. Based on the fifth national development plan of the Islamic Republic of Iran, the Government was due to establish a comprehensive public health-care system in 2011 and to implement it from the following year. Practical and intelligent actions were required to achieve that.

23. Following the successful establishment in 2003 of the first e-learning programmes by Shiraz University in the Islamic Republic of Iran, sustainable telemedicine and tele-health systems had been developed and implemented at the Shiraz Mother and Child Hospital and three other medical centres (Shiraz Shahid Rajaee Hospital, Gerash Hospital and the Iranian Hospital in the United Arab Emirates). The Iranian Space Agency was also planning to invest in implementing telemedicine systems in the country.

24. The following challenges in expanding telemedicine systems needed to be addressed: (a) the cost and quality of the current communications infrastructure, including satellite-based communications; (b) the lack of appropriate legislation, regulations and financial support for developing such applications; (c) the impact of technology import restrictions on improving public health and medical services; (d) the need for cultural and social programmes to promote acceptance of new technologies by experts and the general public; and (e) better understanding of the cost benefits of such applications.

25. It was noted that car accidents were the second most common cause of death in the Islamic Republic of Iran. It was estimated that such accidents claimed three lives per hour in the country, and they caused about 25,000 fatalities and about 250,000 injuries every year (five times more than in other countries in the region and 20 times higher than in developed countries). The cost of medical care for car accident patients in the country was 70-100 billion rials annually.

26. Although telemedicine had generally been accepted as a useful technique for improving access to health-care services, for various reasons it had made little progress. Strategies at the national and international levels had not yet been able to facilitate the proper development of telemedicine. At the national level, efforts must be made to raise awareness among policymakers, health-care personnel and business communities about the benefits of telemedicine. Policymakers should also have a more open-minded attitude towards telemedicine, and overseas development assistance schemes should include telemedicine-provided health as an integral part of the development and promotion of health generally.

27. Telemedicine had the potential to improve the delivery of health care. However, it was necessary to ask whether the resources required to carry out the health procedure, service or programme in question might be better used in other, more cost-effective ways. For example, it appeared that the cost-effectiveness of home telecare for older people and people with chronic conditions was uncertain. The cost-effectiveness for online care in diabetes was also undetermined.

28. Applications such as Telestroke were more cost-effective compared with the usual model of care for stroke victims. Telemedicine was a cost-effective alternative to the delivery of outpatient pulmonary care for rural populations with limited access to subspecialty services. Telemedicine for such care cost $335 per patient per year, compared with $585 per patient per year for routine care and $1,166 per patient per year for on-site care.

29. It was not possible to say whether, in general, telemedicine was or was not cost-effective. However, it was possible to say whether a particular use of telemedicine was effective for a particular condition in a particular setting. The cost and consequences of any telecare intervention must be identified before making any decision on using that intervention.

30. The total number of patients served in the Islamic Republic of Iran by the Petroleum Industries Health Organization was 518,000, of whom 336,000 were employed workers and their families and 182,000 were retired employees and their families. The primary medical system of the organization comprised 63 centres for paramedical services, 70 centres for family medicine and 72 centres for occupational health. Its secondary health-care system consisted of 18 specialized centres, 7 general hospitals and 3 specialized hospitals.

31. The cost (including travel, room and board, medical expenses and hiring a replacement for the patient's post) of transferring a patient to a specialized hospital in Tehran from other regions ranged from $150 to $350. In addition, before the establishment of the Petroleum Industries Health Organization-owned telemedicine system, the wait for an appointment with a medical expert had been, on average, 14 days. After the system was established, the waiting time had been reduced to a maximum of two days. A survey conducted showed that over 80 per cent of patients were satisfied with their tele-visits.

32. In the Islamic Republic of Iran, satellite technologies had proved to be valuable in tracking the extent of disease outbreaks and natural disasters during public health emergencies. Satellite-based remote sensing had also proved to be valuable in tracking environmental influences on childhood asthma: satellite data showed pollution levels and other environmental factors to assist in investigating whether those factors might be triggering asthma attacks in children. Children could then be given therapy to protect them from asthma attacks.

33. The Constitution of Bhutan provided for a free health-care system. A national health-care project that was being implemented could be divided into two parts: a South Asian Association for Regional Cooperation (SAARC) telemedicine project and a rural telemedicine project. The SAARC telemedicine project provided a forum for specialists at the national referral hospital to share and consult on cases with specialists in South Asia and allowed them to keep abreast of the latest developments in their area of expertise. The rural telemedicine project provided a forum for doctors in isolated districts to consult remotely on cases with specialists at the national referral hospital.

34. The Health Help Centre initiative of the Accelerating Bhutan's Socioeconomic Development programme provided the following services: emergency response, a health-care helpline, medical counselling, a health-care information directory, a complaint logging system and a hospital information system. During a visit to hospital, a comprehensive patient record, containing registration data, doctors' notes, prescriptions, laboratory results, in-patient records and administrative notes, was made.

35. The Department of Space Technology had been established in April 2008 under the National Authority for Science and Technology, within the Prime Minister's Office, in the Lao People's Democratic Republic. The mandate of the Department was to implement the overall management and administration of space technology development. It consisted of three divisions: (a) the General Affairs Division; (b) the Space and Terrestrial Affairs Division; and (c) the Service Management Division. Of the various functions of the Department, the most important was the promotion of the socioeconomic benefits of space technology

applications such as remote sensing, geographic information systems (GIS), global positioning systems (GPS), tele-education and tele-health.

36. The Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), the national space agency of Pakistan, with experience in satellite communications, had initiated and successfully established a satellite-based telemedicine network as a pilot project. Very Small Aperture Terminal technology had been selected to provide broadband connectivity for live videoconferencing, the transfer of high-quality biomedical images and other activities that best met the requirements of medical experts. Two medical centres had been connected via a transponder on the Paksat-1 satellite: one at the Jinnah Post Graduate Medical Centre in Karachi and the other at the Shikarpur civil hospital.

37. In order to better utilize satellite-based network infrastructures in telemedicine applications, including teleconsultations and teletrainings, SUPARCO had also established a joint venture with the Jinnah Post Graduate Medical Centre.

38. Owing to a rising chronic disease prevalence rate around the world as a result of the ageing population and natural disasters, it was estimated that the efficiency of medical services provided by hospitals would decrease. To address that problem, "U-Health" technology should be developed. U-Health could be described as a new paradigm of the medical industry and could be defined as prompt accessibility to health management and medical services at any time.

39. Telecare via satellites could be implemented to provide self-management services for patients located far away from hospitals. Major telecare services might comprise telemedicine, health-care management, telemonitoring and tele-emergency, among others. Telecare allowed doctors to provide various virtual services. For the purpose of connecting those doctors, an online telemedical centre could be established.

40. Combining those services, it was proposed to establish a telecare system for emergency situations, a health-care platform and a personal health record database to provide personalized content and self-management via a satellite-based communications infrastructure.

B. Mobile health

41. It was noted that priorities for the twenty-first century ought to be based on emerging dominant trends in health care, including the shift towards shared or integrated care, in which an individual's health care was the responsibility of a team of professionals across all levels of the health-care system. Mobile wireless technologies were increasingly being used in developing countries, and new research and developments in that area had shown the potential impact of mobile health. Rapid advances in technology, ease of use and the falling prices of software and hardware made mobile technologies an appropriate and adaptable tool for bridging the digital divide. Current mobile health devices were able to continuously monitor an individual's pulse and blood pressure and to detect breathing abnormalities associated with bronchial asthma and other chronic respiratory system diseases.

42. Sleep disorders seemed to be one of the main areas in which there was considerable experimentation with mobile health techniques. Expensive telemedicine platforms and network media acted as a barrier to the adoption of the technology by health-care systems in developing countries. Such countries required low-cost, sustainable telemedicine solutions for the local delivery of primary health care. A low-cost portable telemedicine kit called mHealth4U® had been designed and developed, as part of a research strategy on the development of a low-cost tele-health delivery tool, at the School of Telemedicine and Biomedical Informatics in India to address those needs.

C. Tele-epidemiology

43. It was noted that over the past few decades, numerous studies had demonstrated the usefulness of GIS in furthering epidemiological knowledge of various diseases (such as malaria, leishmaniasis, trypanosomiasis, Chagas' disease and lymphatic filariasis) transmitted by vectors (mainly arthropods). Likewise, other studies had shown that methodology to be valid in the epidemiological study of snail-borne parasitic diseases including schistosomiasis and fasciolosis. Those studies included an analysis of climatic and remote sensing data, mainly the normalized difference vegetation index, land cover and land use.

44. Climate played an important role in determining the seasonal and geographical distribution and frequency of many parasite species. Furthermore, climate change and the effects of natural disasters had to be considered, particularly in terms of the various transmission cycles of infectious agents (those transmitted directly and those transmitted by other living beings, especially invertebrates). Studies, including prediction models, on the epidemiology and transmission of human and animal parasites had to incorporate analysis of climatic alterations in the short term as well as in the long term.

45. To shed more light on the effects of climate change and natural disasters on the epidemiology of parasitic diseases, a multidisciplinary group from the University of Valencia in Spain had carried out research on those topics. Fasciolosis had been well studied in some parts of the world, especially in areas where it was endemic in both humans and animals, such as the Andean mountain range, the Nile Delta and the province of Gilan in the Islamic Republic of Iran. Moreover, the influence of the El Niño Southern Oscillation phenomenon and other cyclical climatic events on the disease had also been studied. As climate change and natural disasters were expected to influence the epidemiology of human and animal parasites by modifying their transmission patterns and geographical distribution, parasitic diseases had to be included in future research on the effects of global climate trends on human and animal health.

46. Earth observation technologies had been developing rapidly in recent years, with applications spreading into more and more areas. With regard to improvements in human health, Earth observation data could have different uses: (a) Earth observation data could provide information on the local environment and allow people to select areas that were safer to live in; (b) the sites of outbreaks of infectious diseases could be located using a combination of Earth observation data and GIS, a spatial diffusion could then be modelled and control measures could be

proposed; and (c) the exact location of a patient could be specified using a combination of Earth observation data and GIS, and the most appropriate rescue route can then be plotted.

47. Cases of visceral leishmaniasis were frequent in several parts of the Islamic Republic of Iran. Examples of areas with reported cases of the disease included the Meshkin-Shahr district in Ardabil province and the Azar-Shahr district in the province of East Azarbaijan in the north of the country. Cases had also been reported in the Firuzabad district in Fars province in the south and in some nomadic communities in other parts of the country.

48. The Meshkin-Shahr district, a rural, mainly agricultural area, was a major endemic zone for visceral leishmaniasis in the Islamic Republic of Iran. Of the 1,050 cases of visceral leishmaniasis occurring in the country during the period 1985-1990, 800 (76 per cent) originated in that district. In addition, in contrast to other parts of the country, many people in the north-western provinces kept dogs, not only for shepherding and guarding, but also as pets.

49. Records of human and animal cases in the study area for the period 2003-2008 had been retrieved for eight villages from primary health-care files. Meteorological data, including relative humidity, annual rainfall, the state of local rivers, elevation and the number of days in the year when the temperature had fallen to below 0°C had been provided by the Iranian Atmospheric Science and Meteorological Research Center.

50. For a period of six years, data on climate variables (temperature and rainfall), collected in three observation stations located in Manila, had been correlated with total hospital admissions for dengue fever, malaria and cholera from sentinel hospitals. Analysis revealed that remotely sensed temperature and rainfall data could be used in predicting outbreaks of dengue fever, malaria and cholera. Rainfall data alone, however, were not a reliable indicator of a possible cholera outbreak.

51. Using climate variables, space technology had proved unquestionably useful in providing an early warning of an outbreak of some diseases and in identifying the most vulnerable areas. The extent of the applicability of space technology to human health improvement should be studied, and the possibility of information-sharing, especially for developing countries, should also be taken into consideration.

52. Rheumatoid arthritis and osteoarthritis were widespread problems. Articular cartilage had a limited regeneration capacity and cartilage defects had a limited capacity to heal; only temporary repair tissue would be created in the defect space. Such repair tissue often lacked the biochemical properties and mechanical resilience of the original tissue, thus contributing to further problems. A new approach to the problem could be the co-culture of primary undifferentiated tissue cells with pluripotent mesenchymal stem cells.

III. Observations and recommendations

A. Observations

53. It was noted that the relevance of space technology applications to public health services had significantly evolved.

54. In the area of tele-health, public health authorities could use satellite communications for: (a) delivering health expertise to remote locations; (b) providing training and distance learning; and (c) receiving large amounts of secured data in case of an emergency response, when ground-based infrastructure was not available or could not be used.

55. Mobile health involved the use of mobile devices through wireless technologies in health-care applications. Its applications varied greatly: in developing countries, mobile health was used for diagnoses in rural areas where health-care services were limited, as well as for education and tracking disease outbreaks; in developed countries, mobile health services focused more on improving health care through prevention and healthy living programmes, as well as improved efficiencies. Everywhere, health-care institutions were increasingly recognizing the value of improving care and clinical reach via mobile health technologies.

56. Another satellite technology application in public health related to the need to obtain accurate Earth observations of physical features for operational considerations. The availability of current Earth observation images featuring the visible land characteristics of a region could be of paramount importance when providing emergency services related to health in the presence of a pending hazard threatening a population or following a natural disaster.

57. Both health investigators and public health-care providers had recently undertaken further research into geographical factors as determinants of a wide range of diseases and health conditions. That, along with progress in the development of space technology applications, had resulted in a greater ability to integrate such information into health surveillance and population data for operational needs, decision-making and scientific research.

58. Although satellite technologies had been applied in environmental science for many years, they were still considered by many as an emerging field in the area of public health. In view of the core functions of public health organizations and the set of tools that such organizations utilized, the potential benefit of the various satellite technologies to improve public health services was tremendous. In delivering those services, one of the main applications of space technologies related to the field of satellite communications.

59. Satellite technologies could be used in the global positioning, measurement or characterization of environmental and population events for surveillance, risk assessment or epidemiological research. Epidemiological research related to the domain of landscape epidemiology and tele-epidemiology and was a form of research that was rapidly evolving in its application, integration and acceptance in public health.

B. Recommendations

60. WHO recommendations on facilitating telemedicine development in member States were: (a) to consider a long-term strategic plan for its development and implementation; (b) to establish a national body for telemedicine, supported by the ministry of health; (c) to adopt local policies by engaging stakeholders at all levels

(community, health-care institutions, academic institutions, health administrations and policymaking bodies); and (d) to support and encourage telemedicine research and evaluation initiatives.

61. WHO also recommended that member States should: (a) invest in cost-effective, multi-purpose telemedicine solutions; (b) maximize the affordability and sustainability of infrastructure development (in partnership with the private sector and non-governmental organizations, including through legally binding agreements); and (c) convene a forum with the ministry of health, the information and communications technology sector, the education community and other stakeholders to discuss how to improve health-care delivery.

62. Participants of the workshop made the following recommendations:

(a) A regional telemedicine research centre could be established in Asia. Both the Asia-Pacific Space Cooperation Organization and the Islamic Republic of Iran fully supported that idea, and the Islamic Republic of Iran was ready to host such a centre.

(b) A review should be undertaken of available and cost-effective satellite-based technologies relevant to the specific health-related needs of the Islamic Republic of Iran, of the potential of the contribution of such technologies to the improvement of the health of the Iranian population, and of the possible development of an e-health or telemedicine strategy for the Islamic Republic of Iran and a national tele-health network project.

(c) A national task force or working group should be established that included experts from the ministry of health, medical institutions, the Iranian space agency and the ministry of telecommunications.

(d) Emphasis should be placed on the organization of training courses in tele-epidemiology and GIS, as well as on access to remote sensing data for human health improvement (in particular, for rural areas in developing countries). For that, space technology applications for the diagnosis and treatment of tropical diseases should be considered as a priority, in view of the increasing use of tele-epidemiology in forecasting disease outbreaks after natural disasters and other climatic events.

IV. Conclusions

63. It was noted that significant progress had been achieved in space technology development and its applications for human health over the previous decade. Important benefits had already been realized from several initiatives in developing countries. However, most projects have only reached the proof of concept or demonstration stage. Frequently, they were not fully integrated with local needs, resources and infrastructure. Most of the time, external funding was required to maintain projects.

64. Future and more comprehensive use of space technologies in public health, and in particular in tele-health, would depend on the availability of satellite-based or hybrid communications systems that were cost-effective and provided a competitive service in comparison with land-based telecommunications systems.

65. In tele-epidemiology, the spectral, spatial and temporal resolutions of satellite-based remote sensing data products should be improved to allow better exploration of risk factors and health hazards beyond current capabilities. Incorporation of such remote sensing data into health surveillance and population-based information would result in the increased awareness of public health officials of the benefits of the applications of space technologies and contribute to better training of health-care providers in using space-based products.