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Report of the United Nations/Burkina Faso/World Health Organization/European Space Agency/Centre national d'études spatiales Workshop on the Use of Space Technology in Tele-health to Benefit Africa (Ouagadougou, 5-9 May 2008)

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I. Introduction

A. Background and objectives

1. In its resolution entitled “The Space Millennium: Vienna Declaration on Space and Human Development”,¹ the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) recommended that activities of the United Nations Programme on Space Applications promote collaborative participation among Member States at both the regional and international levels by emphasizing the development of knowledge and skills in developing countries and countries with economies in transition.
2. At its fiftieth session, in 2007, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences planned to be held in 2008 for the benefit of developing countries.² Subsequently, the General Assembly endorsed the United Nations Programme on Space Applications for 2008 in its resolution 62/217 of 22 December 2007.
3. Pursuant to resolution 62/217 and in accordance with the recommendation of UNISPACE III, the United Nations/Burkina Faso/World Health Organization/European Space Agency/Centre national d'études spatiales Workshop on the Use of Space Technology in Tele-health to Benefit Africa, hosted by Burkina Faso, was held in Ouagadougou from 5 to 9 May 2008.

B. Programme

4. Opening statements were made by representatives of the European Space Agency (ESA), the Centre national d'études spatiales (CNES), the Office for Outer Space Affairs of the Secretariat, the Ministry of Foreign Affairs and the Ministry of Health of Burkina Faso.
5. A total of 41 presentations were made during the thematic sessions. Two group discussion sessions, observation and recommendation sessions, and a technical visit were organized. All the sponsored participants made presentations on the status of the use of tele-health or landscape epidemiology programmes for sustainable development in their countries.
6. The discussion sessions were an opportunity for participants to consider the structured discussion topics, with the aim of defining follow-up activities for the region. The participants were divided into working groups in the areas of tele-health and landscape epidemiology. Each working group submitted project proposals for further consideration and selection for financing by interested sponsors.

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. I, resolution 1.

² *Official Records of the General Assembly, Sixty-second Session, Supplement No. 20 (A/62/20)*, para. 84.

C. Attendance

7. Almost 120 participants from the following countries attended the Workshop: Austria, Burkina Faso, Canada, Cameroon, France, Ghana, Italy, Morocco, Niger, Nigeria, Russian Federation, Senegal, South Africa, Switzerland, Tunisia and United States of America. Participants from the World Health Organization (WHO), ESA, CNES and the Office for Outer Space Affairs also attended.

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

II. Summary of presentations

A. Tele-health

9. There are currently about 1,400 communicable diseases and half of the world population lives in endemic areas. It is now widely recognized that not only do seasonal changes play a role in the transmission of many infectious diseases, but so does climate change. Some of those diseases are among the most important causes of mortality and morbidity in developing countries.

10. New and emerging health threats are spreading faster and further, aided by high-speed travel, increased trading of goods and social and environmental changes. WHO and the international community respond to these global challenges within an international health security agenda, which must therefore involve coordinated action and cooperation among and within Governments, the private sector, health systems, media and individuals.

11. The International Health Regulations adopted by the World Health Assembly on 23 May 2005 greatly strengthen shared defences against emerging diseases and other international threats to health. The integration of space assets, including Earth observation, and satellite localization, positioning and communications, could greatly contribute to collective efforts to promote global health security, in particular if used in combination with other geographical data on the occurrence of disease and the availability of resources, and with meteorological and environmental data.

12. Not only does Africa have a major burden of disease, a significant shortage of health professionals and insufficient funding to meet its health needs, but its present health challenges are likely to be compounded by the prospective doubling of its population by 2050. Most African countries are unlikely to achieve their Millennium Development Goals, which include reducing infant mortality and improving maternal health. Despite the fact that the World Health Assembly and the Global Observatory for eHealth see telemedicine as a means of addressing the problem, the uptake of telemedicine remains low in Africa because access to computers and to the Internet there is as yet limited and bandwidth costs are high. In Africa, overworked health professionals often see telemedicine as an extra burden. Innovative ideas and solutions are required to address these problems.

13. Fundamental to African health systems is the rural clinic, which provides primary health care and education, antenatal and maternity services, paediatric care, basic trauma support, services relevant to the disease profile of the area and home care; it also collects epidemiological data.

14. ESA has launched a new central portal embracing its health-related activities and spanning all types of work and projects within the wide theme of space for health.³ The portal provides an overview of ESA-funded, health-related applications and is aimed at citizens, health-care professionals, industry and researchers. The daily health-related challenges encountered by health providers can usually be solved only by an integrated approach, in which the expertise and assets of diverse bodies must be brought together. ESA is pursuing this approach by creating a so-called Integrated Application Promotion (IAP) programme. The IAP initiative has been started in order to raise awareness of new user communities and to promote synergy between themes such as climate and health or energy. IAP will enhance space potential and provide solutions to meet complex needs in the fields of safety, health or energy and will foster new sustainable services. A number of pilot initiatives to demonstrate the capability of the programme have already been launched.

15. The health sector in Burkina Faso has been reformed several times since 1978, with the aim of decentralizing the health-care system, reorganizing hospital and pharmaceutical services and improving services. From 1999 to 2000, an analysis of the health situation in Burkina Faso revealed areas requiring urgent remedial action: the high death rate and HIV/AIDS prevalence, the limited access to health care, the low level of health services and the poor institutional framework. A National Health Development Plan was developed with a view to improving the health of the population and reducing the death rate by 2010. A mid-term evaluation found that the objectives of the Plan were not being reached and new strategies based on “fast-benefit interventions” were developed for implementation during the latter period of operation of the Plan in order to meet the objectives of the Millennium Development Goals.

16. Continuing education for health-care professionals is vital to ensure the quality and efficiency of any health system. In developing countries, such continuing education is rarely available outside the capital city. Since 2000, Switzerland has been involved in coordinating the development of a so-called Telemedicine Network in French-speaking Africa (RAFT), which now includes 10 French-speaking African countries. The core activity of RAFT is the webcasting of interactive courses. With the help of the Health On the Net Foundation, specific courses are organized for the national coordinators of RAFT to develop competencies. Collaboration with the United Nations Educational, Scientific and Cultural Organization and WHO has also been initiated.

17. The RAFT network between Switzerland and Burkina Faso was deployed in 2004. Its main objective is to provide a simple and secure communication tool for units, structures and remote medical clinics. The objective is to create and develop a specialized network in medical imagery. For patients, the benefits are access to a medical expert, no requirement to travel to see a doctor, fewer redundant medical

³ The ESA Space for Health website is available at www.esa.int/SPECIALS/Space_for_health/index.html.

examinations and overall improvement of the health system. For doctors, the benefits are the possibility of providing assistance without the necessity to travel, the possibility of teamwork, and improvements in providing medical care via a simple Internet connection.

18. The national authorities of Niger believe that satellite communication technologies, through tele-health, can provide the means of improving the health of people living in the many isolated areas of the country. Training staff in the use of these technologies is crucial, and time and human resources are needed for training. However, telemedicine can be efficient if there is an appropriate national health policy and strategy, regional and international cooperation is available, and costs and sustainability are taken into consideration. It is hoped to provide Internet connections to the major hospitals and maternity units as yet without Internet access, upgrade existing equipment, increase training for all medical staff, develop opportunities for continuous learning and create national tele-health centres.

19. Throughout the world, people living in rural and remote areas struggle to access quality specialized medical care in a timely manner. Nigeria is currently implementing reforms to improve the health status of its population and to attain a level of health care that would permit all Nigerians to live a socially and economically productive life. The health sector is faced with several challenges in meeting the health-care requirements of the 70 per cent of Nigerians who live in remote and rural areas. Telemedicine is one of the pilot projects implemented via the Nigerian Communication Satellite (NigComSat-1). The objective of the project is to develop a telemedicine system to improve remote diagnoses and to deliver a cost-effective and higher quality specialist service in Nigeria.

20. In terms of both human and animal health, it is now recognized that global climate change has a significant effect on environment-dependent diseases. Climate also plays a role in the transmission of many infectious or communicable diseases. In recent years, Earth observation technology has been used to improve risk mapping for communicable diseases such as malaria, bluetongue and ocean-borne cholera. However, the approaches remain fragmented due to the complexity of the problem and because of the many stakeholders. There is a growing need for operational intelligence and early warning systems for communicable diseases.

21. Recent advances in key communications technologies and in the availability of environmental data, as well as the increased use of geographic information systems (GIS), have made the development of advanced public health information systems possible. Group initiatives such as the Global Observatory for eHealth, initiated by WHO, have been launched. Given that tele-health can be expensive and hard to sustain for small remote communities, experience in Canada suggests that the best solution is to make all the needed applications and services (such as justice, education and Government and community services) available remotely, in order to spread the cost among the largest user base possible.

22. Significant progress has been achieved over the past decade in space technology development and applications for human health. Important benefits have already been realized from several initiatives in developing countries. However, most projects have only been taken to the proof-of-concept or demonstration stage. They are frequently not fully integrated with local needs, resources and infrastructure, and external funding is usually required to keep projects alive.

Canada outlined the experience and lessons learned from several past and current Earth observation and tele-health projects focusing particularly on tele-monitoring projects in the United Republic of Tanzania and the High Arctic, Earth observation for flood mapping in Africa and South-East Asia, as well as epidemiology surveillance in Africa and e-learning to train nurses and midwives in Senegal.

23. The Remote Assertive Community Home care (REACH) project is an example of a means of reducing the cost of health care by reducing the cost of home care while improving the quality of care available to patients. In the future it is hoped to increase mobility by reducing the size of satellite communication ground stations, making it possible to carry a ground station in a briefcase or mounted on a small vehicle using a tracking antenna and to use broadband cellular and handheld units. It is also hoped to develop the possibility of tele-robotic surgery, by which a specialist surgeon can be in any node connected by network, able to operate from a distance supervised by a general surgeon. Such technology could be used in scheduled surgeries, emergency situations, and even on space missions.

B. Tele-epidemiology

24. The CNES strategy for application development aims to convince politicians, stakeholders and the public that space technology can answer societal commitments such as risk management (industrial risks and natural hazards), sustainable development and behaviour quality, and can address health issues. The CNES strategy action plan has led to numerous international partnerships and bilateral cooperation. In Argentina, a surveillance network for dengue fever has been established and extended to the bordering countries of Bolivia and Paraguay and to other pathologies such as malaria and leishmaniosis. In Senegal, countries are cooperating to tackle Rift Valley fever, and in Burkina Faso and Mali a meningitis epidemiological survey has been conducted. In China, avian flu and vector-borne diseases are being combated cooperatively. In the western Mediterranean, Algeria, France, Italy, Morocco and Tunisia are collaborating to combat vibrio-related diseases. ESA is also working on tele-health, with projects such as Satellites for Epidemiology and the Advanced Robotic Tele-echography Integrated Service.

25. For all these projects, CNES is mainly concerned with sustainability; not just to demonstrate the feasibility of projects, but to provide users with services for which they can take over CNES and take on the service and maintenance costs themselves. That is why a fifty-fifty funding scheme is mandatory for CNES and users for the demonstration phase and an economical approach is adopted from the start. Good results have been obtained with this approach: in just two years, two tele-health services have been put into operation. The validation process for a tele-epidemiology service is also under way: the first step of patent submission has been completed and the second step of transferring the technology to make the service operational is in progress.

26. Senegal uses satellite data for monitoring the risk of the emergence of zoonotic diseases in the country. Risk maps of mosquito density can be provided to decision makers in order to plan vector control action or vaccination campaigns. Ongoing development should lead to an early warning system for Rift Valley fever in Senegal.

27. The methodology developed by CNES for the tracking of Rift Valley fever is used in Senegal for another pathology and another eco-zone: malaria in the city of Dakar. The work is innovative and the first results have been encouraging: for the first time, radar satellite products have been used and their ability to detect ponds and humidity has been evaluated. This new satellite technology could be integrated in an early warning system and enable full-time surveillance, even under rainy or cloudy weather conditions.
28. An important tool for disseminating knowledge and ensuring the promotion of the tele-epidemiology approach supported by CNES and its partners is the Re-Emergent Diseases Global Environment Monitoring from Space information system.⁴ The website of the system contains open-access information on thematic areas, projects and project results; access to data from samplings and the results of ongoing projects is restricted, but a metadata catalogue is available. This approach in using space technology for epidemiological surveillance and the possibility of extending it to provide an early warning system for epidemic outbreaks is innovative and complex.
29. The ecology of the vector has to be well understood in order to determine the right time and scale resolution for observing environmental and climatic parameters favourable to vector reproduction. Specific products integrating remote sensing imagery have to be developed, since indicators such as the normalized difference vegetation index (NDVI) are not sufficient. Ouagadougou University, CNES and the Global Francophone Digital University are offering a master's degree course in remote sensing applied to health development and resource management.
30. CNES is actively participating in the development of a project called Satellites for Epidemiology, funded by ESA. CNES has also developed what it calls Multi-platform Data Collection Applications (MEDANY), which enables the rapid development of multi-platform data collection applications for telemedicine and epidemiological monitoring, as confirmed during real-time operational exercises conducted jointly by WHO, the European Centre for Disease Prevention and Control, SAFE partners and the civil authorities of Crete.
31. Another project being furthered by ESA is Advanced Research in Telecommunications Systems (ARTES) for tele-surgery. A surgery robot operated by a nurse or paramedic enables surgical intervention in rural or isolated areas. The project also offers tele-echography facilities; these have been tested successfully in an operational context.
32. The Emergency Medical Aid Unit developed by CNES is a communications terminal with the external dimensions and shape of a luggage container; it is transportable by plane, boat, truck, van or car. The Unit is for use in natural disasters when terrestrial infrastructure has been damaged or destroyed and uses satellite communications to enable decision makers to be connected to their emergency teams and ensure intervention coordination and crisis management. Tested successfully in Chad in 2007, the Unit is equipped with WiFi; the Global System for Mobile Communications (GSM); very high frequency (VHF) and digital video broadcasting (DVB)-radar cross-section (RCS) antennas; and a transceiver. It

⁴ The website of the Re-Emergent Diseases Global Environment Monitoring from Space information system (RedGems) is available at www.redgems.org/.

is also equipped with a telemedicine kit, an advanced first-aid kit, a mini-medical laboratory and facilities to get rapid information on water quality and risk assessment and to carry out an epidemiological survey.

33. Within the context of a national plan for women and child care, tele-echography has attracted great interest. A discussion has been launched on the Emergency Medical Aid Unit and, more generally, on telecommunications facilities as tools for development. The sustainability of service integration based on satellite techniques has been discussed and free or low-cost access to space imagery is needed. Potential users are interested in being provided with a toolbox in order to facilitate the processing of (or “democratize”) space imagery. There is also interest in the use of telecommunications satellites, but the cost has to be made more attractive. The possibility has been discussed of several communities of users jointly funding use as a way of optimizing bandwidth and reducing costs. Satellites are seen as tools for development, addressing urban management, energy and resource management, transport and health issues and the technical feasibility of their use has been demonstrated in various contexts. The focus should be on service sustainability and an economical model that would enable users to afford the cost of the service.

34. Rift Valley fever outbreaks are reported to be associated with climatic conditions and environmental changes. Outbreaks could also be due to changes in water resource and irrigation systems. It has also been suggested that circulation of the Rift Valley fever virus in Kenya may be linked to rainy events occurring after extended dry periods, but this is unlikely to be the case in the Sahel area of Africa. New findings are of major significance: the spatio-temporal distribution of rainy events in the Sahel and their relation to water levels in ponds, which are breeding sites, trigger and modulate Rift Valley fever outbreaks. In the context of climate change, it is expected that these results will contribute to the implementation of early warning systems and improve understanding of the re-emergence of Rift Valley fever in Senegal.

35. In Burkina Faso, access to information, knowledge and health expertise is problematical. Although only at an embryonic stage, telemedicine is already a reality in the region of the Hauts-Bassins of Burkina Faso: e-learning and e-training in telemedicine is offered, leading to a qualification certified by the French University Centre, in partnership with universities in Belgium, Egypt, France, Morocco and Senegal. It is hoped that space technology will make access to medicine available to the whole population of the country. A serious feasibility study is needed, as well as the integration of space technology into national health policies.

36. Remote sensing data applications enable the improvement of meteorological forecasting, as satellite data provide better information on cloud cover and dust layers, and their evolution. Meteorological data from the Meteosat Second Generation satellite are useful for forecasting, climatological applications and many other activities. The advantages of the Meteosat data are the higher quality of the images, real-time monitoring of specific phenomena using larger spatial and temporal resolutions, a higher capacity of data collection, better discrimination of particular phenomena and studies of the Earth radiation balance.

37. The aim of the Association for Moral, Material and Intellectual Support for Children (AMMIE) is to provide support to children and improve community health.

The Association has carried out a project on telemedicine and tele-consultations, in particular using new information and communications technologies to combat HIV. The objectives of the project were to provide basic training and to develop telemedicine, e-learning and activities that would benefit the population. Consideration needs to be given to providing equipment for hospitals and research centres for South-South collaboration, reinforcement of the technical platform and sharing of the very small aperture terminal (VSAT) antenna with local partners.

38. The fields of application of tele-health are the exchanges between professionals (tele-consultations, tele-expertise and videoconferences), remote assistance, in particular in diagnostic and therapeutic advice (tele-assistance), home and ambulatory surveillance (tele-surveillance), tele-diagnostics, tele-surgery, the management of data flow in a health network (health cybernetwork), e-learning and e-management.

39. The Pan African e-Network project is an example of an inter-urban network connecting hospitals and universities in Africa and India via optical cable and satellite. The factors that have ensured its success are the willingness of all the actors to provide support, the establishment of a planning and orientation committee and a well-funded structure for project supervision.

40. The Global Development Learning Network (GDLN) is a global partnership of learning centres that brings together more than 120 affiliated centres. GDLN provides seminars and training and organizes regional and international virtual meetings for various organizations. The Development Learning Center was created as part of GDLN to train the population of Burkina Faso, through e-learning, to adapt to changes brought about by globalization and developments in information and communications technology (ICT) and multimedia. The Development Learning Center exchanges information with similar entities via a studio supported by AMMIE and can be connected to a surgical hospital equipped with a videoconferencing system.

41. Animal migration in Burkina Faso requires the veterinary services to maintain permanent vigilance. The establishment of a network for epidemiological monitoring would facilitate management of the health situation and provide early warning of outbreaks of disease. A better monitoring system is needed, equipped with GIS and Global Positioning System (GPS) for the collection of data in the field. The animal disease epidemiological monitoring network (RESUREP) was created to detect any outbreaks of disease in the country at an early stage and to provide reliable health information for the use of public officials in making announcements about animal diseases and to analyse accurately the extent of outbreaks in order to gauge an appropriate response.

42. A survey to assess the present situation with vectors of tsetse fly has been undertaken within the framework of a project called Creation of Sustainable Tsetse- and Trypanosomiasis-free Areas in East and West Africa, which is the first phase of a 37-country programme called the Pan-African Tsetse and Trypanosomiasis Eradication Campaign. In Burkina Faso, GIS, remote sensing and GPS have been used in an integrated way to manage entomological data. Historical data are gathered and compiled in a GIS and satellite images are processed. The exercise has demonstrated the importance of a database for loading

field sheet data into an electronic format, and of proper planning and good organization.

43. Since 2005, a partnership between the World Francophone Digital University and the University of Ouagadougou has provided direct access to training for all the French-speaking African countries and Asian countries and created a network of universities for the dissemination of knowledge, thereby contributing to the reduction of the digital divide between the North and South. As a result of the partnership, a scientific committee has been established to develop training content. The World Francophone Digital University has chosen to provide training using videoconferencing technology via satellites; while this provides good interactivity, costs tend to be high.

44. Some important health outcomes are associated with the environment, weather and climate: temperature-related morbidity and mortality, the health effects of extreme weather events, air-pollution-related health effects, water- and food-related diseases and vector-borne diseases. The large amount of data provided by Earth-observing satellites can be used to set up health early warning systems capable of revealing any data that signal cause for concern or changing trends. Satellite technology can also be used in health early warning systems to centralize, make accessible and deliver databases to public health bodies, decision makers and health information centres. However, health specialists have not been fully familiarized with the capabilities of space technology and in some cases it has not proved to be the wonder tool that scientists expected. The added value and key advantages of using satellites in early warning systems should be given careful consideration.

45. Every year, West African countries are afflicted with outbreaks of meningococcal meningitis disease. Although the seasonal and spatial patterns of the cases of disease that occur mostly during winter in the so-called African meningitis belt are closely linked with climate variability, the mechanisms responsible for these observed patterns have as yet not been clearly identified. Maps showing the correlations between atmospheric variables and annual cases of meningococcal meningitis enable the selection of relevant climatic variables for the construction of generalized linear models to forecast meningococcal meningitis intensity from year to year. The encouraging results of such simple models have enabled the development of a survey and early warning system of meningococcal meningitis epidemics in African Sahelian countries. The development of such outbreak forecasting could help national and international public health institutions to better control meningococcal meningitis disease.

46. Research into malaria transmission in Niger has resulted in the classification of Niger as a meso-endemic zone. The findings have clearly shown a Sahelian heterogeneity in time and space and demonstrated the need for models to determine all the critical factors of vector abundances.

47. In Zimbabwe, malaria is one of the most important communicable diseases, known to cause high mortality and morbidity. At a conference on the topic of malaria, held at Victoria Falls, Zimbabwe, in 1996, support for reclassifying malaria zones for future control planning was muted. In recent years, remote sensing and GIS have increasingly been used to study disease epidemiology, enabling increased use of spatial analysis to identify the environmental factors that contribute to the

spread of vector-borne diseases by locating “hot spots”, monitoring disease patterns and defining the areas (locations) that require disease-control planning. Data collected by satellites and validated by fieldwork are extensively used for monitoring changes in disease patterns and delineating risk areas. Such data products, when incorporated in a geographic database, could be used to develop a spatial model (malaria-risk zoning) for effective malaria-control planning in Zimbabwe.

48. Disease surveillance is an essential function of public health services. Unfortunately, because of poor health service coverage and difficulties in communication, national epidemiological surveillance units in poorly developed countries face serious challenges in providing decision makers with reliable and timely data. Space technology tools have been used in several areas as a means of collecting and transmitting data on various situations. The use of Argos satellites to transmit health information from isolated health centres was evaluated in Burkina Faso and Niger. Between 2003 and 2005, a pilot study was conducted at four sites in Niger by the Centre for Medical and Health Research (CERMES), in collaboration with the Niger national health information system, Collecte Localisation Satellites (CLS), a CNES subsidiary that provides satellite services in location, environmental data collection and ocean observations, and the Institute for Space Medicine and Physiology (MEDES).

49. Space Surveillance for Epidemics (S2E), a consortium of CNES and its subsidiaries, the Institut Pasteur, the French National Institute for Agricultural Research and the Veterinarian School of Lyon, was established in 2001 with the objective of sharing research and competencies for the use of space technology in the areas of health and the environment and to develop the use of satellites for epidemiological monitoring and the modelling and prediction of epidemics. The network was originally set up for the monitoring of malaria and is now used for the transmission of data on several epidemiological diseases, including in Niger.

50. The Global Digital Solidarity Fund (DSF) is an African initiative that was launched during the World Summit on the Information Society, held in Geneva in 2003, and validated during the second phase of the World Summit, held in Tunis in 2005, with the aim of reducing the digital divide. One of its areas of action is telemedicine and tele-education programmes: in 2008, DSF launched a project that aims to provide 1,000 telemedicine units for Africa. The e-health initiative aims to support the financing of telemedicine units in Africa, as well as to enable health professionals to obtain continuing education, by equipping district hospitals with diagnostic tools and Internet connectivity to enable real-time or deferred exchanges with experts at a distance and to update the medical knowledge of health professionals through e-learning tools. Cooperation with other active telemedicine networks in Africa and with those of WHO, France, Germany and Switzerland is ongoing. The successful reduction of the digital divide would represent a real step towards achieving sustainable development.

C. Space technology, quality of water resources and prevention of environment-related epidemics

51. The VibrioSea project, funded by ESA, is a satellite-based early warning system designed to monitor and prevent vibrio-related diseases in the Mediterranean Basin. The aim of the project is to measure sea surface temperature and ocean colour and to demonstrate that satellites can accurately monitor sea surface temperature close to the coast, thereby enabling prediction of increasing values of vibrio concentration and thus of an elevated risk of vibrio infections.

52. In Tunisia, the possibility of using satellites to monitor the ocean parameters influencing the concentration and distribution of human and animal pathogens is currently under evaluation. Estimates are being made of the risk of infections caused by water- and food-borne bacterial pathogens and of trends in isolation rates of salmonella, shigella and vibrio in humans, food, animals and the environment.

53. Remote sensing by satellite can be particularly useful for the permanent surveillance of rivers and water bodies on a focused scale of a single country or on a large scale of several countries or a region, with a view to protecting the health of fish and humans.

54. Morocco has conducted a large number of projects on space technology applications in the field of health, which have shown that there is a need to ensure that accurate epidemiological data are available and accessible. In particular, special emphasis should be given to the use of satellites in the prevention and surveillance of hydatidosis.

55. In Cameroon, the lack of conformity between the boundaries of health districts and health areas and subdivisional and divisional administrative demarcations makes comparing and harmonizing data from demographic censuses and health surveys difficult, presenting considerable problems for policymakers in the health sector. The lack of adequate information has resulted in inadequate provision of even basic services.

56. To counter such problems, a spatial database using GIS and remote sensing for health facilities and disease monitoring has been developed to continuously update public health decision-making in the 13 health districts and 59 health areas of the East Province of Cameroon. The planning and targeting of interventions, as well as the monitoring of diseases over time, have been customized and the output has been proposed for use in a health management information system.

57. A model of a rural clinic incorporating telemedicine and medical informatics, with integrated open source platforms, offers a possible solution. The proposed model includes fixed and cellular telephone-based connectivity, mobile technologies for patient care, data collection, home care, monitoring of patient drug compliance, education and monitoring. Ground-based surveillance, needed to meet the new International Health Regulations, is also incorporated in the model. The model may serve as an alternative starting point for the discussion on meeting the health-care problems of Africa at the clinic level.

III. Observations and recommendations

A. Tele-health and tele-epidemiology

58. The first discussion session focused on issues and concerns related to the implementation of tele-health and tele-epidemiology in Africa: acquiring epidemiological and health surveillance data, the quality of the available data, data timelines, statistical models for analyses, Government policy and budgetary support, the development of national strategies, capacity-building and continued training.

59. Tele-epidemiology appeared to be the main priority for several African countries. Early detection of and intervention in the spread of water-related vector-borne diseases could significantly ease the burden on the health-care system at comparatively low cost. Yet the implementation of tele-health would require a large investment in communications infrastructure and training, which is not currently available in most regions of Africa. The following observations were made:

(a) Epidemiological models for certain diseases that function well in one country or region may or may not be appropriate in or transferable to another country or region. Such models should be studied and tested before being used in another country or region;

(b) The modelling of different diseases requires different types of data, depending on the disease;

(c) Workshop participants should share resources and project results in order to save time, reduce costs and increase the overall knowledge base;

(d) Governments could set priorities for the study of diseases by consulting the WHO website,⁵ which lists the 10 most common causes of death for each country;

(e) The Food and Agriculture Organization of the United Nations should be invited to contribute to the series of workshops on the use of space technology for human health, since the economic aspects of the food supply make the reporting system for animal pathologies better than its human counterpart and the Organization might be able to provide useful data;

(f) Given that data on human health are difficult to obtain because they are confidential and some data are unavailable for national security reasons, partnerships could be formed with a view to compiling metadata of databases.

B. Telecommunications infrastructure for training, telemedicine and health data collection

60. The second discussion session focused on issues and concerns related to telecommunications infrastructure for use in e-learning, e-training and telemedicine and the timely collection of data on health. Telecommunications infrastructure and

⁵ The WHO website listing the top 10 causes of death is available at www.who.int/mediacentre/factsheets/fs310/en/index.html.

know-how on its use and maintenance in remote and rural regions of Africa are severely lacking and Internet access is generally not affordable by the general population. This presents difficulties in implementing basic tele-health, providing access to continuing medical education and collecting health data from outlying districts in a timely manner.

61. It was agreed that efforts should be directed to:

- (a) Stimulating ideas on practical implementation and sustainability;
 - (b) Encouraging shared efforts with in-kind voluntary support provided at zero or low cost.
-