Macrothink Institute™

Journal of Biology and Life Science
ISSN 2157-6076
2011, Vol. 2, No. 1: E3

Disaster Medicine, Telemedicine and Integrated Vector Control: United Nation's Space Technology Program for Disaster Management

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Received: July 29, 2011 Accepted: Aug 14, 2011 doi:10.5296/jbls.v2i1.823

Abstract

UN-SPIDER-United Nations platform for space-based information for disaster management and emergency response is a new programme established as per UN's resolution 61/110.UN-SPIDER is being implemented as an open network of providers of space-based solutions to support disaster management activities. Besides Vienna, the programme also has an office in Bonn, Germany and Beijing, China. In recent years the program have contributed to making space technologies available for humanitarian and emergency response, UN-SPIDER is the first to focus on the need to ensure access to and use of such solutions during all phases of the disaster management cycle, including the risk reduction phase, which significantly contributed for reducing the loss of lives and property. The UN-SPIDER programme is achieving this by being a gateway to space information for disaster management support, by serving as a bridge to connect the disaster management and space communities and by being a facilitator of capacity-building and institutional strengthening, in particular for developing countries. This paper communicates about emergency, disaster medicine, telemedicine and vector-borne disease management for prevention and control of

harmful health effects due to disasters and optimizing benefits to both human health and the environment.

Keywords: Disaster-Medicine, Space Technology, Telemedicine, UN-SPIDER

1. Introduction

UN-SPIDER is being implemented as an open network of providers of space-based solutions to support disaster management activities. Besides Vienna (where UNOOSA is located), the programme also has an office in Bonn, Germany and also had new office in Beijing, China (UN-SPIDER Newsletter, 2011). Additionally, a network of Regional Support Offices multiplies the work of UN-SPIDER in the respective regions.

1.1 What is Telemedicine?

"The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities" (WHO,2008)**.** Telemedicine is practiced on the basis of two concepts: real time (synchronous) requires the presence of both parties at the same time and a communications link between them Store-and-forward (asynchronous) acquiring medical data (like medical images, bio-signals, etc) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline.

1.2 UN-SPIDER: Aims and Objectives:

UN-SPIDER aims at providing universal access to all types of space-based information and services relevant to disaster management by being a gateway to space information for disaster management support; serving as a bridge to connect the disaster management and space communities; and being a facilitator of capacity-building and institutional strengthening. It has following aims and objectives:

1. To study the climate change in developing countries with special emphasis of the contribution of space-based technologies to mitigate the impact and enhance adaptation to global climate change.

2. Helping developing countries to access and use space-based technologies for disaster management and risk reduction as well as to explore possibilities of capacity development and institutional strengthening.

3. To avail the support of Regional Support Offices and National Focal Points in contributing organizational strengthening and the use of space-based information technology.

4. To provide information regarding the use of space-based applications and solutions targeting disaster-risk management, emergency response, climate change, and health-related issues.

5. To realize the work UN-SPIDER in developing and under developed countries.

6. To form network with representatives of a variety of countries and regional and international institutions engaged in these types of activities.

7. To identify strategies to bridge the gap between the space and the disaster management communities.

8. To coordinate among the developing and under developed countries regarding use of space-based technologies for disaster-risk management, emergency response, climate change, and health-related issues.

9. To collect additional Country Profiles as proposed in the UN-SPIDER for further Work plan.

2. Major areas of Telemedicine Technology Adopted

2.1 Tele-Consultation

Tele-consultation refers to the communication between two health practitioners to determine whether or not to refer a patient to a different location for further medical treatment. In urban areas, this is quite straightforward: pick up the phone or send an email. Very often the patient can be referred to another doctor in the same. Blake, E.H. and Tucker, W.D. (2004) reported internet protocol based tele-consultation underlying principles of the Internet Protocol and presents the case for using these principles as a metaphor for building communication services in South Africa. These innovative types of services are applicable to our digital divide realities. This case study of a rural tele-consultation system enables remote rural doctors and nurses to communicate wirelessly over long distances with Wi -Fi and VoIP in less than perfect conditions.

2.2 Tele-Diagnosis

The patient with the local doctor consults the specialist, obtains the line of diagnosis. Raymond L. H. *et al*(1974) for the first time observed the feasibility of tele-diagnosis based on 1000 patient transactions by means of a two-way audiovisual microwave circuit, physicians at the Massachusetts General Hospital provided medical care to 1000 patients 2.7 miles away at the Logan International Airport Medical Station. This case study demonstrates that tele-diagnosis can increase the availability of quality medical care.

2.3 Tele Monitoring and Tele-Treatment

The patient obtains the line of treatment from the specialist. Miriam V.H. *et al* (2008) studied context aware tele-monitoring and tele-treatment for patients with chronic disorders like epileptic seizures and the uncontrolled movements in spasticity, chronic low back pain. For tele-monitoring workers focused on affected neuromuscular functions because of sudden and only partly predictable, exacerbations; applications concern epileptic seizures and the uncontrolled movements in spasticity. For tele-treatment the focus was on treatment of patient with chronic pain. In case of tele-treatment and tele-monitoring care is delivered in another way than traditionally done. When offering care remotely, the face to face contact

between the professional and patient is less intensive and it is the challenge to use technology instead to deliver care at least as effective and efficient. It is expected that technology can fulfill various roles in these tele-treatment and tele-monitoring concepts. This technology can be used to obtain relevant health data of the patient by acquiring its bio-signals and relevant context information, to transport data from the patient to the professional, to provide the patient with information concerning the health status or changes in health status. Case study pointed out that technology indeed is able to fulfill these roles.

Similarly there is tele-education and tele-training; for continuing medical education, training for doctors and paramedics from a higher level hospital/institution; tele-support for psychological, mental and social support during disasters. Video conferencing is the most common form of monitoring a patient at home and use of known devices like blood pressure monitor and transferring the information to a caregiver. The peripheral devices can be attached to computers or the video-conferencing equipment which can aid in an interactive examination (tele-otoscope, tele-stethoscope, etc). UN- Spider works in various fields of disasters:-

1. Disaster Medicine, Telemedicine and Integrated Vector Management
2. Pre-hospital Application of Telemedicine in Acute-Onset Disaster Situations.
3. Review of space application support for disaster and emergency medicine
4. UNOOSA Activities in Tele-Health and Tele-Epidemiology

3. Space Aid

Space Aid is UN-SPIDER's framework to facilitate fast and efficient access to space-based information for countries, international and regional organizations. This includes all types of information provided by earth observation satellites, communication satellites and global navigation satellite systems. While operating, UN-SPIDER receives a request for support from a National Focal Point, Regional Support Office, or an UN Agency. Users indicate their needs in consultation with UN-SPIDER experts. UN-SPIDER forwards the request to all partners of the framework. The providers select products they will give on voluntary basis. All partners have the opportunity to contribute to any request. All opportunities to obtain imagery and other data free of charge will be exploited. Once the required technology becomes functional Space Aid will also be in a position to automatically task multiple satellites according to the needs of requesting users. Partners inform on the Knowledge Portal about their intended contribution to avoid duplication of efforts, and to allow end users to have quick access to what is being prepared (UNOOSA, 2010).

3.1 Telemedicine in India

ISRO has the following Telemedicine Program in India 1) Remote/Rural Hospitals and Specialty Hospitals 2) Continuing Medical Education (CME) 3) Mobile Telemedicine Units 4) Disaster Management Support (DMS).

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3.2 Disasters Covered by Space Aid

Disaster	Region	Date
Flood	Cuvelai Delta, Namibia	28/03/2011
Earthquake, Tsunami	Honshu, Japan coastline	11/03/2011
Floods	Senegal	02/09/2010
Floods	southern Sudan	01/09/2010
Volcano	Indonesia	29/08/2010
Floods	Burkina Faso	28/07/2010
Floods	Pakistan	22/07/2010
Floods	Sudan	15/07/2010
Floods	Moldova, Rivers Prutand Nistru	01/07/2010
Tropical Cyclone	Pakistan	02/06/2010
Tropical Cyclone	Guatemala	28/05/2010
Volcano	Guatemala	27/05/2010
Floods	Pakistan/Hunza River	11/05/2010
Floods	Tajikistan	07/05/2010
Floods	Kenya	01/05/2010
Earthquake	Northwest China	14/04/2010
Floods	Kazakhstan	12/03/2010
Floods	Mozambique	09/03/2010
Earthquake	Eastern Turkey	08/03/2010
Landslide	Uganda	01/03/2010
Earthquake	Chile	27/02/2010
Floods	Ukraine	25/02/2010
Tropical Cyclone	Tonga	15/02/2010
Tropical Cyclone	Cook Islands	11/02/2010
Floods	Gaza	21/01/2010
Earthquake	Haiti	12/01/2010
Earthquake	Solomon Island	04/01/2010
Cyclone	Fiji	14/12/2009
Floods	El Salvador	09/11/2009

(Ref: KML of UN-SPIDER Space Aid activations from 2009 to 2011 processed by Peter Stumpf)

4. Telemedicine Technology: Telemedicine applies use of following Equipments

4.1 Wireless Communication

Communication during disasters is frequently inadequate. In addition to having competent communication skills, medical responders must have access to adequate, effective, and reliable communications equipment. Wireless communication technologies are rapidly evolving. The medical community needs a basic understanding of existing and emerging technologies to fully exploit these new resources. Wireless communication technologies for

disaster response include radio pagers, radios, cellular telephones, satellite communications, and personal communication services.

a) WLAN:- It provides and creates an easy to set up, reliable, secure, easily available and flexible system for essential communications services at a disaster site**.**

b) Bluetooth:- The electronic equipments, such as standard mobile phones and networks fails during disaster , for managing evacuation routes, or for obtaining information about victims location and status, the standard Bluetooth devices has the guarantee of their application in indoor areas. These electronic equipments, restores communication links during disasters.

c) Wi-Fi:- Wi-Fi is a branded standard for wirelessly connecting electronic devices. A Wi-Fi device, such as a personal computer, video game console, smartphone, or digital audio player can connect to the internet via a wireless network access point. An access point (or hotspot) has a range of about 20 meters (65 feet) indoors and a greater range outdoors. Multiple overlapping access points can cover large areas but needs pre-existing internet connection. It can work as a small office during disasters.

d) WiBro:-Wireless Broadband, A new mobile wireless technology favored by the South Korean government could pave the way for new wireless services for millions of users in Asia and Eastern Europe. The South Korean government believes WiBro (Wireless Broadband) services will become the mobile equivalent of broadband DSL (Digital Subscriber Line) connections and the standardization of the technology later this year could help international adoption during disaster recovery. WiBro offers 3Mbps download speeds at distances up to 1 kilometer from an access point for devices traveling at up to 60 kilometers per hour,

e) Cellular technology: - Japanese who carry phones serviced by NTT Docomo, Japan's dominant cell phone carrier, can opt to have alerts about earthquakes pushed directly to their phones. The technology that makes this possible, the Area Mail Disaster Information Service, is designed to deliver detailed alerts as quickly as possible. This service is uniquely enabled by a little-known technology known as Cell Broadcast, or SMS-CB. It's totally unlike traditional, point-to-point SMS, in that it can be broadcast directly from cell towers to every phone in range and does not use more bandwidth when sent to more users. In this way it's just like a over-the-air television or radio, where bandwidth requirements do not increase as more users receive a signal.

f) CDMA vs. GSM: - Code Division Multiple Access (CDMA) is a technology currently the dominant network standard in North America. Global System for Mobile(GSM) communications was invented in 1987 by the GSM Association. CDMA offers faster data download and would therefore be the favored choice for data transfer. GSM is catching up fast however, but its EDGE technology is subject to interferences. Both require service provider’s antennae or towers which may get collapse during disaster.

***g)* Wi-MAX: -** In contrast to fixed landline, Wi-MAX mobile services operate on a portable basis anywhere within range of provider's towers. Customers have a modem with antenna in their laptop. Mobile Wi-MAX technology is seen as a complement or competitor to cellular and hot spot services.

4.2 Satellites

i) Uses-The uses of satellites in disaster management are becoming more integral to reducing reaction time and providing accurate information to rescue and disaster control operations. Satellites are used in disasters for communications, remote sensing and mapping. Meteorological and storm warning satellite technology can help with predicting disasters and setting up precautionary activities.

ii) Communications-Satellite communications are increasingly used to transmit information back and forth in remote areas that do not receive cell phone reception. Government agencies and relief organizations can receive up-to-the-minute reports to send help where it's needed most. During disasters, when the local infrastructure get destroyed , satellite communications are the only option for getting information out quickly. Satellite phones are easy to carry and make good portable communications devices. Mobile satellite terminals can easily be set up in disaster zones to facilitate good coverage. The International Telecommunications Union is a division of the United Nations that makes satellite technology available to countries that experience mass disasters and need immediate links set up at the disaster sites.

iii) Internet-High-speed Internet access can be switched to satellites in the event of a disaster. Many businesses are incorporating back-up systems that would rely on satellites in the event of a major disaster. First responders can react to communications sent out by a firm that is hooked up to satellite Internet sources. Emergency crews can utilize satellite Internet options when their communications systems are down as a result of a major catastrophe if they are prepared.

4.3 Broadband Global Area Network (BGAN)

It is accessible in Europe, Africa, Middle East, Asia, North and South America.

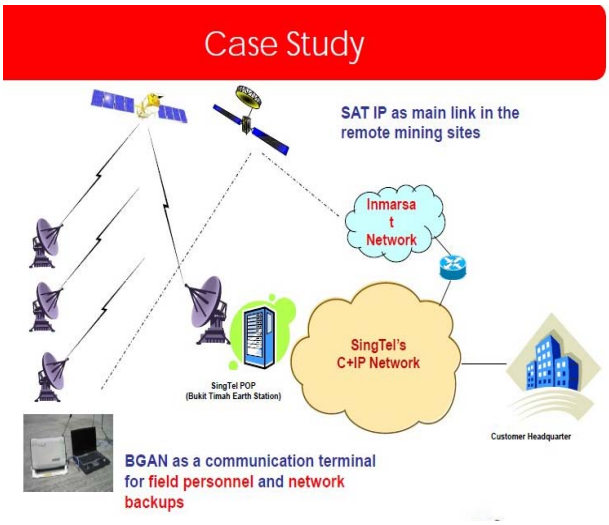

Figure 1. Broadband global area network

4.4 Telemedicine for Special Situations

Telemedicine connectivity has been provided every year since 2002 at Pampa, at the foothills of Sabarimala shrine in Kerala in India where lakhs of pilgrims visit the shrine. Here the

Telemedicine connectivity is provided between the Temple Board Hospital at Pampa and Amrutha Institute of Medical Sciences, Kochi and Trivandvam Medical College Hospital. Several pilgrims availed the facility and some lives were saved. Similar efforts will be made for other places also.

4.5 Telemedicine during Tsunami

The ISRO's Telemedicine facilities at three hospitals -GB Pant Hospital, INHS Dhanvantari at Port Blair, Andaman Island and Bishop Richardson Hospital at Car Nicobar along with ISRO Grama sat network at eight islands was effectively used during post Tsunami disaster relief work for the benefit of the remote population of Andaman and Nicobar Islands. More such Telemedicine centers are being planned at the primary health centers of various islands of Andaman and Nicobar in India.

As soon as the danger of a nuclear fall-out at the Fukushima Daiichi power plant became obvious, UN-SPIDER increased the cooperation with staff of the International Atomic Energy Agency (IAEA) by means of exchanging data and by sharing information. In this context, UN-SPIDER supported as possible monitoring activities related to the threat of a nuclear fall-out and the effects it could have on the region. Everything mentioned above was done within a few hours after the disaster occurred, providing valuable assistance to the response community by publicizing their efforts and results in a timely manner(UN-SPIDER News letter, 2011).

5. The Future

ISRO's Telemedicine endeavor is expanding its outreach and has the potential to open up new frontiers for facilitating rural healthcare in India. Encouraged by the steady growth of its Telemedicine programme, ISRO has also envisioned the development of "HEALTHSAT", an exclusive satellite for meeting the healthcare and medical education needs of the country at large. This satellite, when deployed along with wireless and terrestrial communication links, can bring a large change in augmenting the present healthcare delivery system in the country (UN-SPIDER News letter, 2011).

5.1 Rural Health Establishments in Developing Countries

Andrés Martine (2000, 2002) carried out EHAS Program in 39 rural sites of the Alto Amazonas province, in the center of the Peruvian Amazon region with emphasis on the pilot scheme deployed. The EHAS program has five lines of action. The researchers found that the study was the first feasibility and impact analysis of a rural telemedicine project for a developing country that includes a large sample of isolated communities (39 in the same province) using radio-based voice and data (electronic mail) communication technologies. This project has clearly demonstrated, supported by convincing statistical evidence (in excess of 95% in all cases) that the use of technologies appropriate to the available local resources (easy to use, robust and low operating costs) solves an important part of the efficacy and efficiency problems at rural primary healthcare level. It does so by improving the speed of resolution and diagnostic capacity of the health sites, by speeding up the patient evacuation system, by enhancing the efficiency of epidemiological surveillance mechanisms, by

facilitating pharmaceutical deliveries and by reducing the widespread sense of isolation, both professional and personal, felt by the rural health personnel.

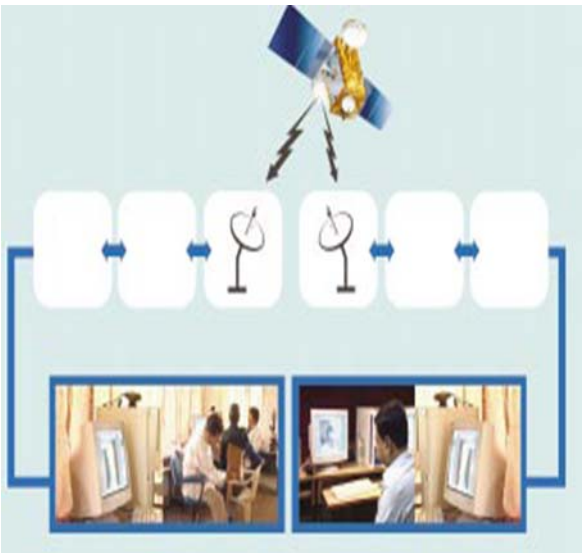

Figure 2. Satcom based Telemedicine connectivity

6. Space Supports for Epidemic Prevention: UN-SPIDER has the following object tools concerned with epidemic prevention and control.

6.1 Objectives

1. To analyze the geographic information required to monitor the risks of epidemic outbreaks and create prediction models

2. To assess latest satellite communications tools for data transmission with field-level epidemic surveillance teams in remote areas

3. To explore ways in integrating space-based technologies with epidemic control systems to prevent the outbreak of diseases after natural disasters

6.2 Recommendations and Perspectives

Epidemic outbreak is one of the most fatal catastrophes, especially in developing or least developed countries. Moreover, ecological and environmental changes caused by natural disasters can lead to epidemic outbreaks. For example, malaria outbreaks in the wake of flooding are a well-known phenomenon in malaria-endemic areas. Most of post-disaster infection is spawned by poor sanitation, a lack of safe drinking water and contaminated food. Nowadays, GIS technology is used to improve risk mapping and make prediction models of epidemic diseases such as SARS, Avian influenza, malaria, and ocean-borne cholera. In 2003, the outbreak of a new epidemic called Severe Acute Respiratory Syndrome (SARS) in China and worldwide menaced the people's life. As SARS spread fast, the epidemic grew like a weed in a number of large cities in China. Beijing is one of the cities with most affected people. New scientific technology manners are needed to control and analysis the spread situation of SARS.

Beijing SARS control and alarm information system was built based on GIS technology, presented the epidemic data spatially and displayed the spatial distribution of confirmed SARS cases, especially the spatial distribution of people who have stayed with confirmed case patients but have not been isolated, so that decisions can be made to control the spread of SARS. Meanwhile, this system takes full advantage of GIS spatial analysis function, the user can query and analyze confirmed and suspected cases according to time and spatial position, and perform classification and statistics according to different indices and spatial positions. In the system, forecast can be made on potential affected area and the result can be displayed with both images and text, which can help government departments to make informed decisions, and provide information for the public to take corresponding measures (SARS: Situation Management and Publishing,2003; MOH, PRC, China).

Satellite technology also provides communication tools with regional epidemic surveillance teams to gather field information in remote high-risk areas. However, the approaches are still fragmented due to the complexity of the problem and the knowledge gap between medical experts and space experts. UN-SPIDER should provide a gateway for acquiring information on space-based technologies for epidemic risk analysis for health workers. The broad spectrum of needs is typically generated by the end users in the epidemic surveillance field. An integrated discussion with space experts and health workers will lead to answers to increase the potential of efficient epidemic prevention systems based on space-based technologies.

7. Community of Practice Spider Global Thematic Partnership:

In recent years the International Strategy for Disaster Reduction (ISDR) of the United Nations and other organizations have reiterated the fact that the number of disasters and corresponding economic losses have been increasing steadily. As stressed by ISDR, hard-won gains related to development are being wiped out by these disasters in many developing countries. Taking into consideration this fact, the General Assembly of the United Nations established the United Nations Platform for Space-Based Information for Disaster Management and Emergency Response (UN-SPIDER) programme through its resolution 61/110 of 14 December 2006 to provide universal access to all countries and all relevant international and regional organizations to all types of space-based information to support the full disaster management cycle.

The Hyogo Framework for Action 2005-2015 (HFA), endorsed by 168 member states of the United Nations, commits national, regional, and international agencies to tackle disaster-risk reduction efforts to build the resiliency of nations and communities to disasters. To facilitate the achievement of the proposed goals identified in the HFA, ISDR is promoting the establishment of thematic platforms or partnerships to support National Platforms for Disaster Reduction. In this context, UN-SPIDER launched the UN-SPIDER Global Thematic Partnership on the Use of Space-Based Information to Support the Full Disaster Management Cycle during the Second Session of the Global Platform for Disaster Reduction, which took place in Geneva, Switzerland, on 16-19 June, 2009. The SPIDER Global Thematic Partnership had a vehicle to conduct tasks such as:

1. Increasing awareness on the use of space-based information for disaster risk reduction and emergency response.

2. Facilitating the exchange of experiences, lessons learned, and best practices concerning access to and use of space-based information for disaster risk reduction and emergency response across continents.

3. Promoting horizontal cooperation in the conduction of activities targeting access to and use of space-based information for disaster risk reduction and emergency response.

4. Providing a forum for members to reach consensus regarding how to approach certain issues, to harmonize efforts, and to standardize procedures globally.

8. Spider Latin America and Caribbean Thematic Partnership

The SPIDER Latin America and Caribbean Thematic Partnership has been set up within the context of the SPIDER Global Thematic Partnership to provide technical advisory support to National Platforms for Disaster Reduction which are being promoted by the International Strategy for Disaster Reduction as a way to mainstream disaster risk reduction efforts at the national level. The SPIDER Latin America and Caribbean Thematic Partnership will promote, through the efforts of the institutional partners, access and use of space-based information and services for disaster-risk reduction and emergency response activities.

9. What does UN-SPIDER do?

UN-SPIDER ensures that all countries and international and regional organizations have to access and develop the capacity to use all types of space based information to support the full disaster management cycle. UN-SPIDER is achieving this by being a gateway to space information for disaster management support; serving as a bridge to interlink the disaster management and space communities; and being a facilitator of capacity-building and institutional strengthening.

On 14 April 2010 the Southern Quinghai region in the north-west of China experienced a 6.9 magnitude earthquake which left hundreds of people dead and the majority of the population injured. The importance of high resolution satellite imagery was highlighted by the fact that the affected area of Yushu County is located 500 miles from the nearest major airport, which raised logistical challenges for relief operations on the ground. Immediately after the first reports of the earthquake, the UN-SPIDER team activated the SpaceAid framework in order to assist in the response phase by bridging the space data providers with the Chinese disaster management authorities in charge of the response (UN-SPIDER Newsletter, 2010).

9.1 How Can Space Aid be Triggered?

Space Aid support can be accessed by the UN-SPIDER National Focal Points (NFP), UN-SPIDER Regional Support Offices (RSO) and UN organizations. UN-SPIDER is working on bringing in local partners as well. Authorized government agencies and major international and regional organizations will also have access to Space Aid as procedures

develop. Users can request the support through a hotline that can be accessed through telephone, e-mail or fax. A central coordination unit coordinates and follows-up on all requests. This framework is operational on a 24 hours a day/7 days a week basis in order to respond timely to a disaster.

9.2 How Does Space Aid Mechanism Work?

1. UN-SPIDER receives a request for support from a NFP, a RSO, or an UN agency. Users indicate their needs in consultation with UNSPIDER experts.

2. UN-SPIDER forwards the request to all partners of the framework. The providers select products they will give on a voluntary basis. All partners have the opportunity to contribute to any request. All opportunities to obtain imagery and other data free of charge will be exploited. Once the required technology becomes functional (now under development), Space Aid will also be in a position to automatically task multiple satellites according to the needs of requesting users.

3. Partners inform on the Knowledge Portal about their intended contribution to avoid duplication of efforts, and to allow end users to have quick access to what is being prepared.

10. Summary and Conclusions:

Thus space technology can significantly contribute to many elements of disaster management operations and when disaster occurs, the existing terrestrial communication infrastructures could be damaged. Then, telemedicine through satellite can play a key role in the diagnosis and treatment of urgent patients in the field. The rapid access to a wider range of specialists and medical procedures, better emergency triage of patients, the administration of overall medical systems and patient care through seamless delivery of services by satellites can provide chances for both patients and medical staff to fulfill various urgent medical care requirements. Satellite connection brings surgeons in remote area into operating room oceans away. Especially, in trauma situation which occurs frequently in many disaster, fast care matters most, patient are treated in most critical stages. In this urgent situation, telesurgery using satellite communication can be only answer. Thus this paper communicates about emergency, disaster medicine, telemedicine and vector-borne disease management for prevention and control of harmful health effects due to disasters and optimizing benefits to both human health and the environment.

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