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NEWSLETTER

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In focus

What Satellites can see - Earth Observation for Disaster Response

Nothing gives us a quicker overview than looking at something from a bird's perspective. In a disaster situation, after an earthquake or during a flood, satellite images can be determining factors in answering pressing questions such as: Which roads are still accessible, which houses are damaged, where could a helicopter land?

Satellites can see so much more than meets the eye. By using a wider electromagnetic spectrum (as opposed to the optical spectrum our eyes are capable of perceiving), satellites can help detect objects or natural features that are invisible to the human eye. While some sensors in a lot of ways work like a normal camera taking a picture, other sensors can detect surface heat as well as changes in the land use or lang cover, measure the elevation of the ground, determine salinity in our oceans or track how healthy the vegetation is.

Hurricane Isaac approaching Louisiana, USA, August 2012

Since the first weather satellite was launched over 50 years ago, space technology has contributed immensely to the way we can observe and track environmental, hydro-meteorological, geographic and human occupation changes on our planet. Today, a huge number of Earth Observation satellites look at us from above, predicting the weather, assessing natural hazards and helping us reaching those affected by a disaster.

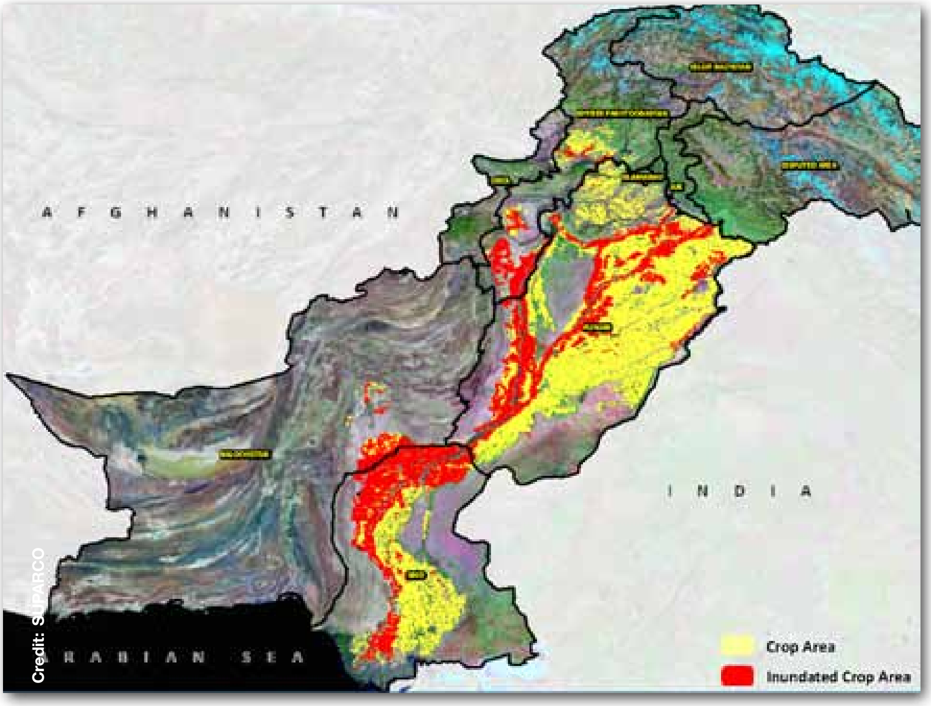
Because of its enormous potential to provide vital information for disaster relief operations, UN-SPIDER is striving to enable all countries to access, interpret and effectively use the data and information that satellites provide from several hundreds of kilometres above our heads. The considerable costs of imagery as well as the technical know-how needed to process and interpret satellite data can be obstacles in this process. By providing trainings and by connecting end-users to satellite image and service providers, UN-SPIDER is aiming to bridge the gap between the providers and users of satellite imagery.

In this newsletter, we invite you to take a closer look at the usefulness of Earth Observation data for disaster response - by presenting international actors who provide such information but also by telling two success stories from UN-SPIDER's partners in Iran and Pakistan dealing with floods and droughts, respectively.

In this issue

Case Study

Pakistan: Monitoring Floods from Space



Pakistan: Crop Damage Assessment of the 2010 Floods

Pakistan is one of the most disaster-prone countries in the world. A massive earthquake in 2005 killed more than 73,000 people, injured 100,000 and destroyed houses, schools, hospitals, roads and bridges worth billions of USD. In 2010 and 2011, devastating floods caused massive human casualities and property losses. According to the National Disaster Management Authority (NDMA), the floods in 2010 affected an area of about one fifth of the country, claiming over 2,000 lives and injuring 3,000. Flash floods and landslides triggered by monsoon rains caused severe damage to infrastructure in the affected areas. Entire villages were washed away, urban centres were flooded, homes were destroyed, and thousands of acres of agricultural lands were damaged with major soil erosion occurring in some areas.

Due to the large size of the areas affected by floods and the limited accessibility caused by damages to the infrastructure, it was very difficult to assess the extent and nature of the damages through manual field surveys alone. Satellite imagery could fill in the information gaps, provide coverage of inaccessible terrain and unique data often hard to obtain from ground surveys. Satellite data thus provided information on factors crucial to the relief and recovery efforts during the flood, for example on shelter areas for displaced people, crucial infrastructure such as roads, bridges, railways or airports as well as damages to crops like sugarcane, rice, cotton or maize.

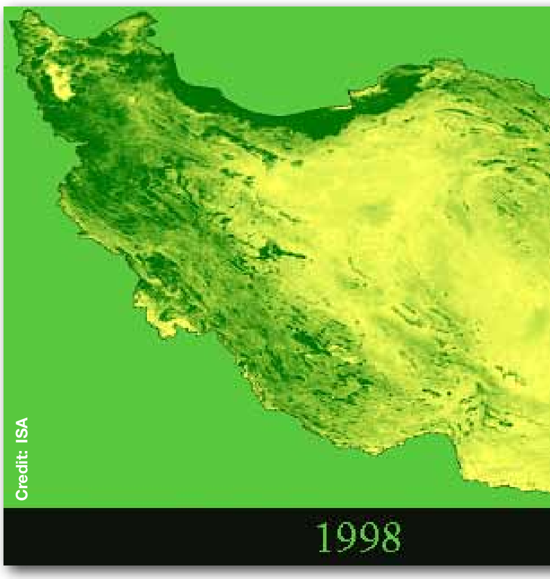
SUPARCO, the National Space Agency of Pakistan and host to a UN-SPIDER Regional Support Office, used both satellite-based remote sensing techniques and geographic information systems to provide an analysis of the flood-related damages to federal and provincial disaster management agencies.

At the time of the 2010 flood, SUPARCO retrieved multi-date, multi-resolution satellite images of the flood-affected areas from the available archive to examine the pre-flood situation. For comparative analysis of the pre-flood with the post-flood situation, up to date imagery from the SPOT constellation was programmed for daily updates and the data was directly received at SUPARCO's Satellite Ground Station in Islamabad. Additionally, data from NASA's Aqua and Terra satellites was received at Pakistan's Ground Station in Karachi for the daily monitoring of the affected areas on a regional scale and for damage assessments. Through the International Charter "Space and Major Disasters" maps based on Landsat, GeoEye and QuickBird data supported the monitoring of the extent of the flood.

Through their rapid response mapping software, SUPARCO is able to automatically create maps according to user criteria from the raw satellite data. Disaster reports can be generated for different administrative boundaries and provide estimates of impacts on settlements and infrastructure. The generated reports display the current disaster situation of the affected area using the latest downloaded satellite images. It also calculates damage statistics dynamically by overlapping disaster and infrastructure layers.

Updated and reliable information on flood prone areas from satellite imagery is vital to assess damages to houses, infrastructure and crops in the case of a disaster. But it can also support decision-making processes to better address preparedness and mitigation planning and can thus contribute to reducing flood risks in the longer term.

www.suparco.gov.pk



Case Study

Satellite-based Drought Monitoring in Iran

Asia and the Pacific have experienced severe droughts in the recent years. The Islamic Republic of Iran has a particularly high degree of aridity and pronounced rainfall variability in large parts of its territories and is therefore highly vulnerable to drought. For example, a severe drought from 1998 to 2003, which has been unparalleled during the last 30 years, seriously affected 18 of the country's 28 provinces, mostly in south eastern and central Iran.

Droughts tend to follow a cycle. The cycle begins with a "Normal" situation with good rain. Conditions gradually deteriorate through an "Alert" stage, when water, pasture and other resources are becoming harder to access, to an "Emergency" stage, when resources become very scarce and widespread famine and disease may occur. When the rain eventually does fall again, water supplies and vegetation recover, and people can rebuild their livelihoods (the "Recovery" stage). Because these stages progress gradually, it is possible to anticipate them if early warning and monitoring systems are in place.

In the past decades, Iranian planners and authorities have paid great attention to studies focusing on mitigation and control of droughts. However, these studies used climatic data such as precipitation which are frequently scattered or insufficient and not available for timely drought detection, monitoring and decision making. Therefore, the use of other techniques or data, such as satellite-derived information to provide an efficient means for drought monitoring, seems inevitable.

UN-SPIDER's Regional Support Office in Iran, hosted by the Iranian Space Agency (ISA), as well as other government agencies in Iran are increasingly using space-based information for drought management, recognizing that droughts would not necessarily turn into disasters if natural resources could be more effectively monitored with the help of space technologies.

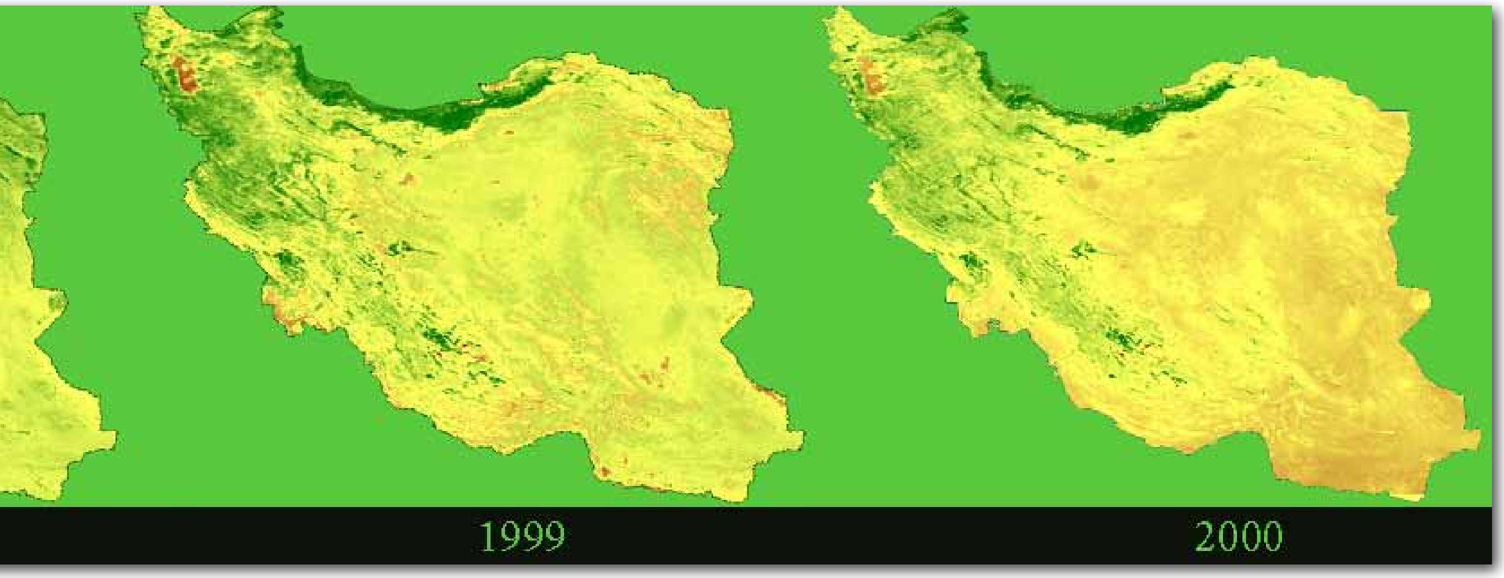
A recent study done by ISA researchers shows that modelling the changes of indices derived from satellite data produces reliable and accurate results. Indices derived from satellite data can visualize and track changes in the vegetation of an area, precipitation or the land surface temperature over a period of time.

One way of measuring droughts from space is using indices, such as the Normalized Difference Vegetation Index (NDVI), the Vegetation Health Index (VHI) and the Vegetation Drought Response Index (VegDRI). A method employed in recent years in Iran is based on the relationship between satellite data on vegetation, in the form of a vegetation index, and rainfall. Vegetation indices are functions of the spectral contrast between the reflected near infrared and visible radiance from the Earth's surface. This contrast is greater for vegetation than for soil, and hence a higher vegetation index reveals a denser cover and vigour of vegetation. The relationship of this index to rainfall is used as an indicator of drought in Iran.

Drought modelling from satellite data and artificial neural networks (ANN) is another research area of the ISA. NOAA AVHRR data of the last 15 years - archived by ISA - are used as inputs in order to establish a model based on a neural network. Other important inputs for this model are meteorological data series of 30 years, Iran climatic maps and Iran basin maps. Finally, monthly drought intensity maps are produced and distributed. There are three ANN models used in this research: ADALINE, MLP and BRF. So far, the results have shown that the best satellite-based index for drought prediction by using ANN is the Temperature Condition Index (TCI). MLP has proven to be the best artificial neural network model for drought prediction three months before the beginning of the next drought.

www.isa.ir

Drought Monitoring in Iran: Satellite-based Changes of Vegetation Indices using NOAA-AVHRR Data



DID YOU KNOW?

You can access a lot of archived satellite imagery and up-to-date geospatial data products online - free of charge. We have assembled some of the most important links on the UN-SPIDER Knowledge Portal for you:

www.un-spider.org/data

International Cooperation

Organisational Mechanisms for Space-based Information

The effective use of space-based information for disaster response depends on many factors. The most crucial one is obviously the access to such data. A lack of financial or human resources can prevent end-users from acquiring satellite data and processing them into relevant maps. Several international mechanisms have been set up to support countries affected by disasters to better respond to emergency situations with the help of damage assessment maps, reference maps or other products derived from satellite data. These mechanisms are usually based on voluntary contributions from satellite providers, space agencies and value adders such as United Nations entities, research centres or private companies. This allows the mechanism to provide space-based information to requesting end-users free of charge. Below, three of these mechanisms are presented.

GIO EMS-Mapping

The Copernicus GIO Emergency Mapping Service (GIO EMS-Mapping) provides all actors involved in the management of disasters caused by natural hazards, man-made emergency situations and humanitarian crises with timely and accurate geospatial information derived from satellite remote sensing completed by available *in-situ* or open data sources. It is funded by the European Commission and implemented through framework contracts. The mechanism covers disasters ranging from tsunamis or volcanic eruptions to technological disasters like oil spills. The goal of the mechanism is to cover all phases of the disaster management cycle. Because of its two activation modes - rush mode and non-rush mode - the mechanism is open for highly urgent emergency situations as well as disaster risk reduction and disaster recovery efforts.

http://portal.ems-gmes.eu/

Sentinel Asia

Sentinel Asia is a voluntary-basis initiative led by the APRSAF (Asia-Pacific Regional Space Agency Forum). It was established in 2005 as a collaboration between space agencies and disaster management agencies. It supports disaster management activities in the Asia-Pacific region by providing Earth Observation satellite data. Member States of the Asian Disaster Risk Reduction Center (ADRC) and the Joint Project Team implementing the mechanism can activate Sentinel Asia in the case of major disasters. The products delivered by the mechanism usually include satellite imagery, value-added maps as well as on-site photos of the disaster area. Apart from reacting to onset disasters, Sentinel Asia also regularly publishes wildfire hotspot monitoring and rainfall information for the Asia-Pacific region on their website.

http://sentinel.tksc.jaxa.jp

International Charter Space and Major Disasters

The International Charter Space and Major Disasters is a worldwide collaboration, through which satellite data are made available for the benefit of disaster management. Following the UNISPACE III conference held in Vienna, Austria in July 1999, several space agencies joined forces to make available satellite-based information free of charge to UN agencies and other Charter members. Building on a decade of success in making satellite data available for disaster response, the International Charter started opening its doors even wider. In September 2012, the mechanism announced a new principle: the Universal Access. Any registered national disaster management authority is now able to submit requests to the International Charter in the case of a major disaster. (Read more on the Universal Access initiative on page 6.) As opposed to some of the other mechanisms, the International Charter only covers the immediate crisis phase - usually within ten days after a disaster has struck. After the request to the 24/7 On-Duty Operator, the mechanism within a short period of time provides satellite-derived maps to the requesting user. The maps are usually also made available as free downloads on the International Charter's website within days of the activation.

www.disasterscharter.org

Dr. Stefan Voigt, DLR Center for Satellite-Based Crisis Information

Dr. Stefan Voigt is working as a senior researcher at the German Aerospace Center's Remote Sensing Data Center (DLR DFD). He is one of the key initiators of DLR's engagement in satellite-based disaster relief support and has been conceptualizing and implementing the DLR Center for Satellite Based Crisis Information (ZKI).

Dr. Stefan Voigt (right) at Work in ZKI's Situation Room

ZKI provides satellite-based information products to relief organisations and public authorities in case of disasters. Can you tell us about a recent example where ZKI became involved and what types of satellite images/products were provided?

A recent activity was the mapping of a refugee camp in Jordan, where tens of thousands of refugees from Syria are currently living. Due to heavy rainfall the camp was experiencing a flood situation. ZKI used optical as well as radar satellite data to create reference maps showing the pre-event situation and maps of the current situation in the camp, for example showing its size, the characteristics of the dwellings and the degree of the flooding. The radar data proved especially useful due to its ability to indicate the water surfaces.

What is the advantage of using satellite imagery for disaster response as opposed to using only ground-based information?

Satellites enable us to assess a large area, almost anywhere in the world, at once and from above. Geospatial information derived from satellite imagery therefore allows very precise assessments of an affected area. Satellite data is available also extremely fast and can provide up-to-date information on a global scale. Furthermore – in the case of radar data – it is also almost fully independent from weather conditions, such as cloud coverage or rain seasons. However, one thing needs to be emphasized: Satellite-derived information always needs to be combined and fused with ground data in order to provide reliable and useful support for disaster relief and mitigation. Thus, space and ground information complement each other, when putting together an assessment of a given situation.

In a disaster situation, reliable information needs to be provided quickly. However, communication infrastructures can be damaged in crisis situations. How does ZKI ensure that end-users receive the satellite data or maps in a timely manner?

At ZKI we always aim to act as fast as possible. Our workflows foresee that maps are produced and disseminated no later than eight hours after we receive the satellite data. However, the biggest bottleneck in the information flow is often still the programming of the satellites. We therefore try to anticipate the needs for satellite imagery in given disaster situations and programme our satellites in advance whenever possible and appropriate. In case of a major disaster situation like the Haiti Earthquake in 2010 or the Great Eastern Earthquake in Japan in 2011, we don't wait for a formal request to come in, we start the satellite programming and preparatory work immediately after the seismic alerts and first news come in. In order to ensure that our maps reach the end-user, we use as many channels as possible: Email, web, ftp-servers and print outs. In some disaster situations, for example, responders take our printed maps with them on the airplane when traveling to the disaster area.

DLR has been a member of the International Charter „Space and Major Disasters“ since 2010 and is currently chairing the Charter. What role does ZKI play in this international mechanism?

ZKI implements the technical and operational elements of DLR's contribution to the Charter. The Charter is set up such, that a clear sharing of work exists and there are different roles and functions defined within the workflow. Each Charter member takes on different roles in the process of an activation. In doing so, we here at ZKI take on four different roles, depending on what is needed. We serve as "Emergency On-Call Officer", where we request programming of all relevant Charter satellites, once the Charter is activated. We provide the role of "Project Manager" for Charter activations, where we coordinate all Charter value adding, communication with the user and reporting for a given disaster case. As a "Data Provider", we deliver TerraSAR-X as well as Rapid Eye satellite data to the mechanism. Finally, as a satellite mapping facility we serve as "Value Adder" and create disaster maps from all kinds of raw satellite data that come in, so that the end-users can make use of the satellite information in an effective way. The secretarial functions and the current role as the chair of the Charter are primarily covered by our DLR colleagues in the Space Administration section of DLR.

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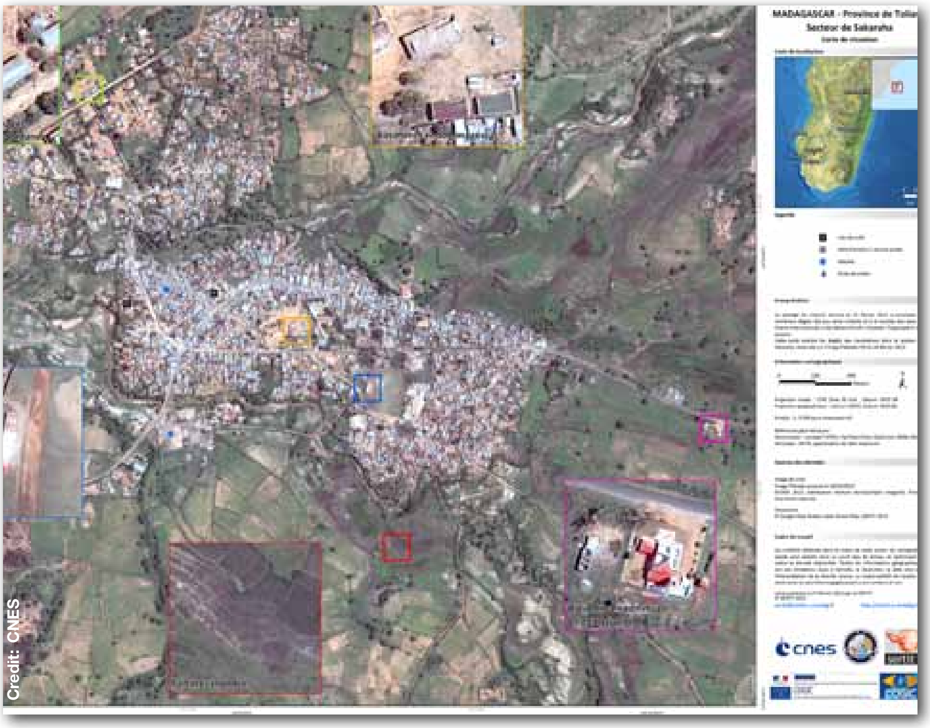
Open Access: The International Charter Space and Major Disasters

In September 2012, the International Charter Space and Major Disasters adopted the principle of Universal Access so that any national disaster management authority could access the benefits of this international mechanism.

The United Nations Office for Outer Space Affairs (OOSA) welcomed the initiative as it fully reflects the mandate of UN-SPIDER. The UN-SPIDER programme aims to ensure that all countries have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle from prevention to recovery. As a Cooperating Body to the Charter, OOSA has always been promoting the mechanism in all its capacity building and advisory support activities. With the Universal Access initiative, this commitment is taking another meaning and the Office has been working closely with the Charter's Secretariat in defining concrete actions, not only for outreach, but also for the implementation of the initiative.

The assets of UN-SPIDER are seen as complementary to the Charter's mandate and to the objectives of the Universal Access initiative. Fifteen UN-SPIDER Regional Support Offices (RSOs) offering a global coverage of expertise in remote sensing and disaster management; forty-five institutions and individual national focal points with direct responsibility in disaster preparedness or emergency response; track-records in technical training; and a focus on building bridges between stakeholder groups that would not otherwise find platforms for exchange and sharing of data, information or knowledge.

These networks and approaches are now more available to the Universal Access initiative. In June 2013, at least four RSOs will be attending a Charter's training for Project Managers in Italy. Opportunities for regional training activities using the RSO network or in parallel to other activities of OOSA are considered. This can potentially increase the reach of the Charter in developing further its roster of experts to support and manage activations. OOSA can also support the Charter in ensuring that the outputs of those activations are well disseminated and reported upon by Project Managers. This feedback is essential to improve the quality of the services. OOSA will also promote the initiative in informing and supporting eligible national authorities when products from the Charter can be adequate and timely.



Madagascar: Cyclone Damage Assessment Map, February 2013

Through the support for the Universal Access and for the Charter, OOSA will continue to promote the needs, requirements and expectations of the UN Member States. To cater to the increasing number of requests for assistance following many disasters smaller in area or impacts, which also need to be mapped and monitored, OOSA is developing partnerships with RSOs, Space Agencies and image providers. The Office strongly believes in developing complementary mechanisms to provide for needs in all phases of the disaster management cycle, including for preparedness, early warning and reconstruction. It is also considering all types of threats to the environment and to the human population.

By promoting dialogue, OOSA looks toward a better understanding between providers and users so that expectations and contexts are fully taken into account. That way, the resources available are used in an optimal manner and to the benefit of all stakeholders involved.

UNITED NATIONS

The United Nations Office for Outer Space Affairs (UNOOSA) implements the decisions of the General Assembly and of the Committee on the Peaceful Uses of Outer Space and its two Subcommittees, the Scientific and Technical Subcommittee and the Legal Subcommittee. The Office is responsible for promoting international cooperation in the peaceful uses of outer space, and assisting developing countries in using space science and technology. In resolution 61/110 of 14 December 2006 the United Nations General Assembly agreed to establish the "United Nations Platform for Space-based Information for Disaster Management and Emergency Response - UN-SPIDER" as a new United Nations programme to be implemented by UNOOSA. UN-SPIDER is the first programme of its kind to focus on the need to ensure access to and use of space-based solutions during all phases of the disaster management cycle, including the risk reduction phase which will significantly contribute to the reduction in the loss of lives and property.
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