Earth observations in support of national strategies for disaster-risk management

A Synergy Framework for the integration of Earth Observation technologies into Disaster Risk Reduction

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Executive Summary

Leveraging Earth observations (EO) and related space-based information systems is crucial in addressing the priorities highlighted in the Post-2015 Framework for Disaster Risk Reduction (DRR).

A number of partners involved on a global scale in space technologies want to reaffirm their strong interest in addressing synergies to better respond to the requirements established in the post-2015 framework. The initial partners are from organizations both within and outside the UN system with mandates and/or competencies in space, satellite technologies and other Earth Observation technologies having in common the aim of responding to the requirements of the DRR community worldwide. Priority areas of action will be defined and undertaken by the partners following the Third UN World Conference on Disaster Risk Reduction in Sendai in consultation with national and international stakeholders. These actions will set the agenda of activities for the global partnership which is committing itself to fostering the use of Earth Observations and space-based technologies at all levels by strengthening existing mechanisms, and ultimately contributing to a better integrated and wider use of such technologies in DRR around the world with a concerted approach.

Partners will work toward the sustained availability of satellite and ground observations, as well as other sources of data and information in support of Disaster Risk Reduction and management. The ultimate goal of this proposed Synergy Framework is to support countries all over the world towards a sustainable process to address their DRR requirements.

1 Purpose

The purpose of this white paper is to illustrate the commitment of a number of partners involved in space, satellite technology and other Earth observation technologies to work together to respond to the requirements of the global DRR community to implement the post-2015 framework for disaster risk reduction within the resources available. The definition of the priority actions will be undertaken by the partners following the Sendai conference in consultation with national and international stakeholders. The partners are committed to work within a synergy framework, open to partners, providers and users equally, so that specific requirements and user needs can find a collaborative response by mobilising the potential of all EO expertise available globally.

The Third United Nations World Conference on Disaster Risk Reduction (3rd WCDRR, Sendai, Japan 14-18 March 2015) will mark the beginning of a new era for disaster risk reduction (DRR) policy and its application in disaster risk management (DRM). On this occasion, the post-2015 framework for disaster risk reduction shall be adopted defining the priorities for the next fifteen years (2015-2030); in addition participants in the 3rd WCDRR will announce how they intend to practically contribute to the implementation of this framework. In that scope, several national governments and regional and international organisations with a mandate in Earth observations and Disaster Risk Reduction are working together to set up a multi-stakeholder partnership to group their resources and forces to conduct a series of major activities aiming at addressing in a sustained manner the most important needs of the user communities in DRR. The activities that could be conducted by the partnership are of different nature: technical, scientific, national capacity building, data and information policy, etc.

The mission of the partners will be to foster the sustained availability of satellite and ground observations, and their use in support of disaster risk management in combination with other sources of data and information such as socio-economic and models outputs for improving the quality of the risk information targeted to decision-makers; and to support countries in the use of observation data and derived information for their national disaster-related activities – respecting national choices of data and tools. This voluntary commitment will be made during the working session entitled “Earth Observations and High-Technology to Reduce Risks”, to be conducted as part of the official activities of the WCDRR.

2 Preamble

Earth observations and space-based applications have seen a considerable advance in the last decade, and such advances need to find their way in applications related to DRR, climate change and sustainable development, including in the indicators to monitor advances in these areas.

The post-2015 framework for disaster risk reduction, to be adopted during the 3rd WCDRR is an action-oriented framework for disaster risk reduction that builds on modalities of cooperation linking local, national, regional and global efforts. Earth observations from ground and space platforms and related applications will play a key role in facilitating the implementation of the post-2015 framework and represent a unique platform to observe and assess how risks have changed in recent years, as well as to track the reduction in the level of exposure of communities to natural hazards.

This white paper focuses mainly on Earth Observations from space but it also addresses the use of other sources of data (airborne, marine, in-situ, socio-economic and model outputs) in combination with remote sensing data.

Earth observations (EO) and Space-based technologies are already playing a crucial role in contributing to the generation of relevant information to support informed decision-making regarding risk and vulnerability reduction and to address the underlying factors of disaster risk. For example, long series of Earth observation data collected over more than 30 years already contribute to track changes in the environment and in particular, environmental degradation around the world. Whether due to inadequate land-use policies, lack of awareness or understanding regarding such degradation, or inadequate use of natural resources including water and the oceans; Earth observation technologies are now routinely employed by many Ministries of Environment and Natural Resources worldwide to monitor the extent of degradation and a basis to design and enact new environmental management policies.

Over the last decade, efforts carried out by the major space data and space-based information providers have focused mainly on the response phase of disasters - including the establishment of successful operational support services such as the International Charter: Space and Major Disasters. Rapid urbanization and increased frequency of intense weather events have led to growing economic and human losses from disasters. International organisations have addressed this through improved disaster risk reduction policies and programs. As a way to contribute to confront these emerging challenges, space agencies are now applying the diversity and range of satellite observation technologies available to global disaster risk reduction and preparedness. Full-scale use of satellite EO for disaster risk management will be achieved when more users become aware of available benefits and possible future applications. Satellite EO plays a complementary role to other data sources, but offers unique scope and coverage. In some cases, because in-situ observations can be difficult to obtain, remote sensing data may be the only reliable data source. It provides both updated hazard information and exposure data. In fact, despite the significant efforts of international organizations and governments to preserve and increase the quality and quantity of observed data in many regions of the world, the current array of in-situ networks for collecting data and related information management systems can still be inadequate, and where available is often deteriorating.

Major space agencies around the world are working together to better coordinate their efforts and resources in order to improve their support to disaster risk reduction. As a way to achieve this strategic long-term objective space agencies will work in close cooperation with relevant major stakeholders (UN System, the World Bank, regional organizations, others), practitioners and user communities at global, regional, national and local levels, to identify the most critical user needs and to establish a long-term realistic and feasible plan for a sustained and coordinated response to those needs, in line with the top priorities identified in the post-2015 framework for disaster risk reduction.

This White Paper represents the voluntary commitment of several national governments and regional and international organisations with a mandate in Earth observations to establish a global

partnership dedicated to enhance the use of Earth observations and Space-based technologies worldwide in the context of the post-2015 disaster risk reduction framework. This document outlines several aspects which are of relevance in the context of this global partnership including efforts conducted by international stakeholders, recent advances in the use of Earth Observations and Space-based technologies, challenges that need to be addressed, policies, and potential aims.

3 Current Partners

Organisations and entities that have expressed their interest to be active partners for this initiative are currently:

> The United Nations Office for Outer Space Affairs (**UNOOSA**) and United Nations Platform for Space-based Information for Disaster Management and Emergency Response (**UN-SPIDER**), the Unite Nations Economic and Social Commission for Asia and the Pacific (**UNESCAP**), the United Nations Office for Disaster Risk Reduction (**UNISDR**), the United Nations Institute for Training and Research (**UNITAR**), UNITAR's Operational Satellite Applications Programme (**UNOSAT**), the Group on Earth Observations (**GEO**), the Committee on Earth Observation Satellites (**CEOS**), the European Union (**EU**), the International Working Group on Satellite Emergency Mapping (**IWG-SEM**), the German Aerospace Center (**DLR**), the Chinese Academy of Sciences – the World Academy of Sciences Centre of Excellence on Space Technology for Disaster Mitigation (**CAS-TWAS SDIM**), the International Centre for Integrated Mountain Development (**ICIMOD**), the International Water Management Institute (**IWMI**), the National Emergency Commission of the Dominican Republic (**CNE**), the Disaster Management Centre of Sri Lanka (**DMC**), the National Disaster Reduction Center of China (**NDRCC**), and the World Meteorological Organization (**WMO**).

ANNEX 1 provides an overview of some of the engagement by current partners in the field of disaster risk management and of major initiatives including those of the UN such as UNOOSA / UN-SPIDER, ESCAP, and UNOSAT; GEO, CEOS, EU Copernicus; as well as initiatives set up by the space community such as International Charter on Space and Major Disasters, Sentinel Asia and IWG-SEM.

4 User Requirements

The ensemble of the partners mentioned above, together with their respective partner networks, currently conduct Disaster Risk Management related activities (DRM) in response to a number of user needs. Success areas have typically concentrated in the response phase, but a growing number of cases show that it is possible to have end-to-end sustained initiatives to deliver usable and reliable data to national and local end users to map risk and vulnerability and track their dynamics over time and space. This type of solutions represents a real added-value in the context of the post-2015 DRR Framework.

The post-2015 Framework for disaster risk reduction identifies four "Priorities for action" that define in general terms the priorities for the next 15 years. The use of space based technologies, remotely sensed Earth observations and in-situ data is explicitly mentioned in paragraphs 22f and 23c, which outline *Priority 1: Understanding, communicating and using disaster risk information*.

In order to coordinate their actions, the partners will need as a prerequisite to identify and assess the top requirements of the disaster management communities around the world and to establish priorities. The identification of user needs will require the active involvement of regional entities including UN Regional Commissions, and also non-UN regional entities and organizations with a stake in DRR and/or in EO and remote sensing, as encouraged by the article 26 of the draft version of the post-2015 framework.

Given the limited resources available, at the very beginning only 1 a selected number of user needs will be addressed in order of priority, through prototyping activities.

5 Fostering the use of Earth Observations and related information in DRR

Several aspects need to be considered when fostering the use of Earth observation applications (both from space and in-situ) in the context of the post-2015 framework for DRR. While the added value of remote sensing data to DRR has been demonstrated on several occasions, several challenges remain to be tackled.

5.1 Added Value of Earth Observations for DRR

There are several good reasons to integrate Earth observations in DRR efforts at national and local levels. Some of these reasons arise from the explicit benefits associated with the use of such observations and technologies. Objective and reliable information on hazard, vulnerability and exposure, presented through an analysis of expected impacts for given risk scenarios, is instrumental for triggering and, more importantly, sustaining the political will and economic strength needed to achieve DRR.

In relation to the explicit benefits associated with the use of these observations and technologies, the following can be mentioned:

- Some studies have demonstrated the cost savings achieved through adequate preventive actions based on reliable risk information that relies in particular on Earth observations.
- The combinations of satellite EO data with other traditional sources of data improve the quality of the information provided to end users, including decision-makers. Sometimes, the in-situ observing network is not covering the entire area of interest and remote sensing data is the only source of data to generate such information or to complement the available data.
- Satellite EO offers the consistent coverage and scope to provide a synoptic overview of large areas, repeated regularly. Satellite EO can be used to compare risk across different countries, day and sometimes during the night, even in difficult weather conditions, and well as in trans-boundary areas where information might be difficult to collect.
- EO data can be used to represent complex dynamics and processes through detailed, unbiased and up-to-date risk maps and models.
- Satellite data offers a unique means to monitor the progress of the implementation of the post-2015 Framework for Disaster Reduction, using globally comparable metrics.

5.2 Challenges in mainstreaming Earth Observations in DRR

The global challenges facing the international community require increasingly broad and timely access to high-quality, integrated and sustained Earth observation data and related information. Earth observations play an important role in making societies more resilient to natural hazards and more adaptive to climate change. However Earth observation data and information are owned by a variety of entities around the world, and no single country is able to acquire the comprehensive data and tools it needs to inform policy decision on globalised matters like disaster risk, environment and climate change.

One of the key challenges identified by UN-SPIDER upon conducting technical advisory missions in more than 25 countries in Asia, Asia Pacific, Africa, Latin America and the Caribbean in the last years is the weak use of Earth observations and Space-based technologies in DRR.

[1] According to a series of **criteria** to defined later.

Other key challenges identified during those missions include the perception of the high cost of satellite imagery and the reluctance to use low-resolution imagery. While high resolution satellite images have to be purchased sometimes, several satellite operators have softened their data policy following the recommendations from the GEO Data Sharing Principles Task Force, offering users a free, full and open access to several thousands of optical and radar images each day. For instance, every day the European Space Agency (ESA) is putting on-line the equivalent of 770 DVDs of EO satellite data, free of charge.

One area of improvement concerns the capacity development of national and local users in the integration of satellite data and information into decision making processes for DRM and response preparedness. While several national and local instances possess GIS capacity, only a few are able to integrate satellite data and imagery to have a more up-to-date decision support tool to monitor risk and plan corrective and emergency actions.

6 A global partnership focusing on Earth observations and Space-based Technologies

The entities and networks mentioned in this White Paper and participating in the WCDRR form the basis of a global partnership committed to fostering the use of EO and Space-based Technologies at all levels through existing mechanisms, and to contribute to a better and more integrated use of such technologies in DRR around the world. The partners have the experience, mandate and networks necessary to provide leadership in the development of tools and techniques to enhance technology applications for DRR, to facilitate the dialogue among the community of providers of EO data and products and the disaster risk reduction community, and to mobilize additional partnerships and capacities at all levels in a synergic way. This will in turn provide visibility to Earth observation solutions for DRR and help define and implement a series of initiatives aiming at providing sustained solutions in response to the most urgent needs of the user community involved in disaster risk management.

Through the conduction of a variety of activities, the partnership will demonstrate that EO satellite data, combined with other sources of geospatial information (e.g. *in-situ* and airborne measurements), socio-economic data and properly linked to modelling, can provide reliable, accurate, consistent and continuous information; which is the foundation for the development and operation of robust DRM systems. This could lead to a set of common approaches for the use of various EO technologies, tools and methodologies in countries willing to strengthen national systems.

6.1 Objectives

The following objectives are at the core of the partnership and are relevant to the ongoing work carried out by the partners:

- Continue to facilitate the dialogue among stakeholders in EO, Satellite-based technologies and the global community of DRR experts and policy makers, including by the compilation and exchange of lessons learned regarding the use of such observations and technologies;
- Serve as a collective source and repository of information on efforts carried out worldwide by the EO and Satellite-based technology communities, including surveys and guidelines to improve the applications of existing and emerging technology to monitor hazards, exposure and risks;
- Generate policy-relevant advice to contribute to the integration of EO and Satellite-based technologies into development process and public policies relevant to DRR, including by facilitating the incorporation of research and technology advances in the activities of the DRR community;

- Facilitate the use of EO and related technology to monitor progress in the implementation of the post-2015 framework for DRR;
- Mobilize additional actors and stakeholders to contribute to efforts conducted by the partnership worldwide.

7 A Staged Implementation Approach

Taking into consideration the notion that a growing number of countries are expected to be involved in the use of EO and Space-based Technologies in the coming years, a gradual approach in phases will be required. The idea is to develop the initiative through three main stages. A Concept phase and a subsequent Prototyping phase will be developed after the WCDRR to focus on strengthening the partnership and its capacity to address the requirements of national and regional users. One of the major tasks during the early Concept phase will be to identify the top priorities and related user needs in terms of disaster risk reduction for the next 15 years, as described in section 4. Then the initiative will focus on operational solutions to provide specific services via synergy among partners.

An initial limited number of early adopter countries from different regions may serve as National Demonstrators. These demonstration initiatives will serve to develop and test approaches and methodologies and may involve some or all of the partners and attract additional regional and local partners.

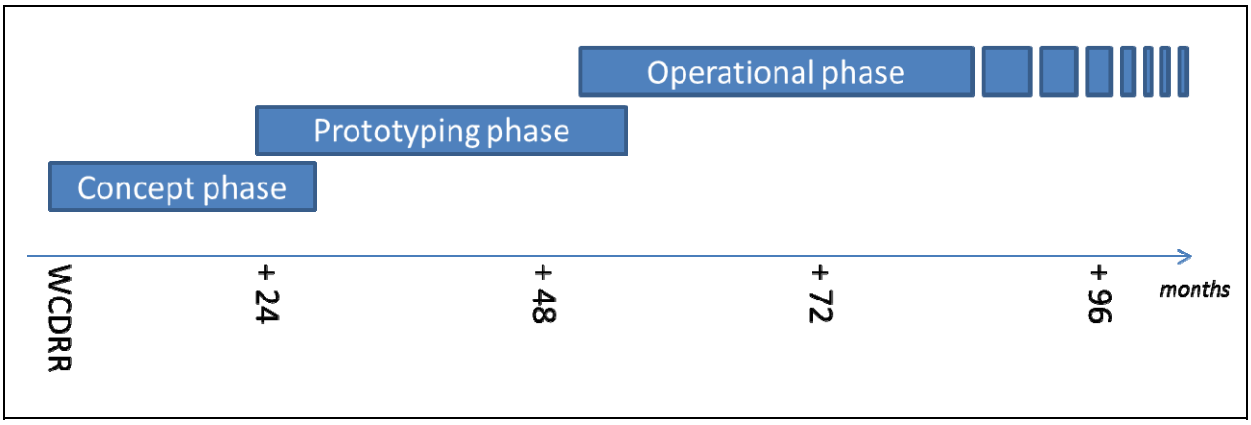

Figure: The three phases of the initiative

8 Framework for Partnership.

8.1 Policy framework on which to establish this partnership

The call for the application of existing and new technology underpinning the Yokohama Strategy (1994), the Hyogo Framework for Action (2005) and the post 2015 framework for DRR (2015) is the policy dimension within which the partners intend to work. This dimension is corroborated by the GEOSS strategy, the CEOS coordinated action and the policies of UN Member States known through the reports of the Committee on Peaceful Uses of Outer Space (COPUOS) and other relevant UN bodies including ESCAP.

The partners agree to work in a non-binding synergy framework with no legal constraints but with a clear commitment to responding to users and advancing the use of EO and remote sensing for the benefit of DRR and the implementation of post-2015 framework. The partnership is open to any potential partners that can join at any time.

Because the various initiatives to be started by the partners will require also staff support from several partners at a time, the format of Project Teams will be used to facilitate the work. Depending on the size and number of initiatives and projects, a Partner Steering Group could be created to facilitate interaction and synergy. Membership of the Partner Steering Group would include the major stakeholders: data and information providers, UN Agencies, the World Bank, donors, GEO Secretariat, the European Commission, national experts and representatives and others on an open ended basis.

ANNEX 1. Examples of Current Partners' Engagement in DRM

This annex provides an overview of some of the engagement by current partner stakeholders in the field of disaster risk management.

GEO

The Group on Earth Observations (GEO) was established in 2005 by the Third Earth Observation Summit in response to calls for action by the 2002 World Summit on Sustainable Development and the Group of Eight (G8) leading industrialized countries. These high-level meetings recognized that international collaboration is essential to exploit the growing potential of EO to support decision making in an increasingly complex and environmentally stressed world.

The Group on Earth Observations (GEO) gathers 200-plus partners comprised of 95 Governments, UN Organizations including UNISDR, UNESCAP, UNITAR/UNOSAT, UNOOSA/UN-SPIDER; international organizations such as CEOS and the major international scientific institutions.

GEOS's signature initiative, the Global Earth Observation System of Systems (GEOSS), represents the collective effort of many governments and organizations, and thousands of individuals, to monitor the Earth system, share and exchange all types of Earth system data, and deliver useful information to society. GEOSS has enabled many countries to access information and thereby provide essential services to address challenges which otherwise would not have been met. In the context of DRR, GEO activities focus on three main areas:

1. Provide support to operational systems and conduct gap analyses in order to identify missing data, system gaps, and capacity gaps;
2. Enable and inform risk and vulnerability analyses; and
3. Develop regional end-to-end systems with a focus on building institutional relationships.

CEOS

The Committee on Earth Observation Satellites (CEOS) was established in 1984 to harmonize the Earth observations community efforts in order to enable easy access and use of data for all users. Besides its prime focus on interoperability, CEOS works closely with other satellite coordinating bodies to promote the exchange of data, optimize societal benefits and inform decision makers to secure a prosperous and sustainable future for humankind, acting as the primary forum for international coordination of space-based Earth observations. For instance, in support to both the UN Framework Convention for Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC), space agencies provide to the climate research community, long series of Essential Climate Variables (ECVs) that are important for a full understanding of the climate system. Many of these are the subjects of current on-going research. The contribution from space agencies to climate change is also very relevant to disaster management as damages from extreme weather-related hazards may triple by 2100. For what concerns disaster management, CEOS is engaged in several efforts related to DRR with a strong involvement of the user community, developing an observation strategy to support specific projects related to a variety of hazards:

- Floods
- Seismic hazards
- Volcanoes
- The Recovery Observatory, a multi-hazard initiative aiming at providing data free of charge (e.g. satellite, in-situ, ...) during several years after a major catastrophe, for reconstruction purposes.

UN ESCAP

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), located in Bangkok, Thailand, is the regional development arm of the United Nations for the Asia-Pacific region. ESCAP serves 53 Member States and 9 Associate Members. It operates as a regional hub for bringing space technology applications to member States to address challenges of disaster risk reduction and sustainable development. ESCAP has been promoting the effective use of space technologies and GIS through its long-standing Regional Space Applications Programmes for Sustainable Development (RESAP) at the regional level, while harmonizing and coordinating existing global and regional initiatives, programmes and resources. By facilitating Asia-Pacific member States to collaborate, countries which have no space programme of their own can access and effectively utilize space-derived data, products and services. ESCAP and its member States, as well as its partners including UNITAR/UNOSAT, UN-SPIDER, UN-GGIM, GEO, APRSAF and CSSTEAP are giving their utmost commitment to bringing the full potential of space technology and GIS applications to the most vulnerable people of the region, leveraging their experience in innovative technology applications through enhanced collaboration and information sharing for a stronger and more resilient Asia-Pacific.

The current major work of ESCAP in the areas of space and GIS applications for disaster risk reduction include:

1) Mobilizing regional resources on near real-time satellite imagery to support disaster-affected countries on early warning, response, relief and damage assessment, through RESAP networks and UNITAR/UNOSAT.
2) Facilitating the operationalization of the Regional Drought Mechanism aiming to use space-based data for effective drought monitoring and early warning. Six countries have requested to be pilots. Two regional service nodes in China and India are functioning to provide space-based data, products, service and capacity building.
3) Developing the standardized online geo-referenced information systems for disaster risk management (Geo-DRM) for countries with special needs (LDCs, LLDCs and SIDS). The Geo-DRM portal combining socio-economic data with satellite imagery can provide a highly effective tool for supporting evidence-based decision making for disaster preparedness and rapid analysis/impact assessment.
4) Leading the implementation, at the regional level, of the Asia-Pacific Plan of Action for Applications of Space Technology and GIS for Disaster Risk Reduction and Sustainable Development, 2012-2017.
5) Providing technical assistance to enhance institutional capacity building in developing countries to address the main gaps and emerging challenges to sustainable development.

UNISDR

UNISDR's mandate has been defined by a number of United Nations General Assembly Resolutions, the most notable of which is "to serve as the focal point in the United Nations system for the coordination of disaster reduction and to ensure synergies among the disaster reduction activities of the United Nations system and regional organizations and activities in socio-economic and humanitarian fields" (UN General Assembly Resolution 56/195).

UNITAR - UNOSAT

Established in 2000, UNOSAT has provided satellite imagery analysis and GIS support in over 300 major disasters to this day. The Programme focuses equally on supporting UN agencies and member states during all phases of the disaster management cycle on the one hand, and on training for

capacity development on the other. UNOSAT training in DRR covers technical aspects of DRR that can be improved by the application of satellite based EO other geo-spatial technologies, including field-data collection apps, live web-mapping and UAVs. A website named GEODRR.org regroups UNOSAT range of DRR applications and shows some key results. Regional programmes in Eastern Africa in partnership with IGAD and in Asia in partnership with ESCAP and ADPC have shown tangible progress in the following key areas:

- Capacity development for the practical use of EO and satellite derived mapping for DRR;
- The application of remote sensing and GIS in support of flood preparedness and hazard mapping;
- Capacity development for the mapping of water resources for sustainable management of hydrological resources;
- Improvement of flood-modelling using global elevation model dataset in partnership with USGS ;
- Development of Early Warning system combining flood models, weather forecasts, climate outlooks, statistical records and pre-programmed satellite imagery collections;

UNOOSA and UN-SPIDER

The United Nations Office for Outer Space Affairs Office is substantively responsible for the promotion of international cooperation in the peaceful uses of outer space for economic, social and scientific development, in particular for the benefit of developing countries. The work and activities undertaken by the Office are influenced by the General Assembly's resolutions relating to international cooperation in the peaceful uses of outer space, the agenda of work of COPUOS, and the overall development agenda of the United Nations.

Since 2006, the United Nations General Assembly established the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) as a programme within the United Nations to provide universal access to all countries and all relevant international and regional organizations to all types of space-based information and services relevant to disaster management to support the full disaster management cycle, and agreed that the programme should be implemented by the Office for Outer Space Affairs of the Secretariat. UN-SPIDER has been established to serve as:

- A gateway to space information for disaster management support;
- A bridge to connect the disaster management and space communities
- A facilitator of capacity-building and institutional strengthening, in particular for developing countries

In its resolution 61/110, the General Assembly of the United Nations decided the UN-SPIDER should work with the different international initiatives aimed at utilizing space-based disaster information, such as the Integrated Global Observing Partnership, the Global Earth Observation System of Systems (GEOSS), the International Charter Space and Major Disasters, and UNISDR.

ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD) is an intergovernmental organization headquartered in Kathmandu, Nepal, with regional member states comprising of Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. Established in 1983, ICIMOD over the 30 years of its existence has worked to promote sustainable and resilient mountain development in the Hindu Kush Himalayan (HKH) region for improved and equitable livelihoods through knowledge and regional cooperation.

ICIMOD has given strong emphasis on Earth observations and space based information for disaster risk management in the HKH region. ICIMOD has spearheaded a comprehensive capacity building programme and supported various national development partners in disaster risk management in the regional member countries. ICIMOD has used EO and GIS in tandem to identify and monitor hotspots of change relate to natural hazard such as mapping of potentially dangerous glacial lakes and development of regional flood outlooks and early warning, some of which have led to multi-lateral funded mitigation projects.

Through the partnerships with regional and international agencies, ICIMOD is assisting it member states in rapid response mapping in case of disaster event thus supporting national agencies on effective implementation of response intervention. ICIMOD is a Regional Support Office (RSO) of UNSPIDER, and Data Analysis Node (DAN) of Sentinel Asia of JAXA, and draws support from these strategic partners in responding to the regional needs. Being a Himalayan Hub of SERVIR, a global programme supported by USAID and NASA together, ICIMOD has leveraged EO and geospatial tools for innovative solutions – community based early warning system, satellite radar altimetry for flood early warning, disaster information management system, forest fire monitoring and detection using SMS alerts among others. ICIMOD has developed interactive online applications (http://geoportal.icimod.org/) in support of informed decision making. ICIMOD has been strong proponent of universal access to data in the region and has led establishment of national system for data sharing, Bhutan Geospatial Portal (www.geo.gov.bt) being the first to be launched in October 2014.

IWMI

The International Water Management Institute (IWMI) is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries. It is headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. IWMI is a member of CGIAR, a global research partnership for a food-secure future.

IWMI has strong focus on disaster risk management and water management solutions with the theme on Water Availability, Risk and Resilience in particular the activities related to water-related disasters, such as floods and droughts, climate variability and change, and various adaptation options, including improved planning and operation of alternative forms of surface and subsurface water storage.

IWMI is working closely with national, regional and international agencies in the event of major disasters to provide emergency response mapping products through partnership with space agencies. IWMI is a Regional Support Office (RSO) of UNSPIDER, Data Analysis Node (DAN) of Sentinel Asia of JAXA, Participating Organisations in Group of Earth Observations (GEO) and key host institution for TIGER NET, a European Space Agency (ESA) initiative to support water resource monitoring in African region. IWMI has developed several regional climate hazard mapping products including floods, droughts, extreme precipitation, heat waves and sea level rise to identify multi-hazard areas in better targeting financial resources towards adaptation measures in South Asia. The ongoing near real-time monitoring on floods and droughts using Earth observation data in several countries in Asia and Africa to support disaster agencies and Ministries in Agriculture and Water Resources. The new research programme on index-based flood insurance developing sustainable ex-ante disaster risk financing mechanism to improve livelihood and agriculture risks in the flood prone region. IWMI maintains open access to any general users in access to data and models, maintains GeoNetwork platform and developed several interactive applications to support better decision making process.

More about IWMI and Water Data Portal can refer http://www.iwmi.cgiar.org/ and http://waterdata.iwmi.org/

CAS-TWAS SDIM

CAS-TWAS Centre of Excellence on Space Technology for Disaster Mitigation (SDIM) is established in 2013. The SDIM is jointly sponsored by the Chinese Academy of Sciences (CAS) and The World Academy of Sciences for the advancement of science in developing countries (TWAS), and hosted at the Institute of Remote Sensing and Digital Earth (RADI), CAS.

The goal of SDIM is to conduct much-needed research on disaster mitigation through advanced space technologies, especially space-borne Earth observation technology and provide knowledge transfer in developing countries through joint research, education, training, workshop and advisory services. SDIM is guided by four objectives:

- To implement outstanding multi-disciplinary and collaborative scientific research activities focus on disasters in relation with floods, droughts, earthquakes, tropical cyclones, storms, etc. with a main emphasis in developing countries.
- To offer associated education programs and customized training for experts and decision makers from developing countries.
- To promote a scientific dialogue and a platform for the exchange of best practices regarding Earth observations in developing countries.
- To provide technical and strategic advisory services to developing countries.

International Charter on Space and Major Disasters

International Charter on Space and Major Disasters is an international collaboration with very simple objectives: to task satellites in response to requests from a user organization and provide the user organization with fast access to satellite data to help manage natural and technological disasters.

Members of the Charter unanimously endorse the principle of 'universal access' to data for the benefit of societies worldwide in times of disaster. The goal of the Charter is to address the needs of disaster management organizations supporting countries affected by disaster.

Sentinel Asia

Sentinel Asia is a voluntary initiative by collaboration between space agencies and disaster management agencies, applying remote sensing and Web-GIS technologies to assist disaster management in the Asia-Pacific region. It was established in 1993 after the Asia-Pacific International Space Year Conference (APIC) in 1992.

Sentinel Asia Partners include Space agencies, related governments, regional and international organizations, institutions responsible for applying space technology. The Joint Project Team consists of total 96 organizations including 80 organizations of 25 countries/region and 15 international organizations.

EU Copernicus

Copernicus is a civil, space user-driven programme under civil control, building on the existing national and European capacities, as well as ensuring continuity with the activities achieved under its predecessor the Global Monitoring for Environment and Security (GMES). Copernicus monitors the Earth to support among others the protection of the environment and the efforts of civil protection

and civil security, provides information for the implementation of European policies, fosters global initiatives, and supports international coordination of space-based Earth observations at CEOS. Copernicus is one of Europe's main contributors to GEO's signature initiative, GEOSS. Copernicus consists of the following components: (a) a service component ensuring delivery of information in the following areas: atmosphere monitoring, marine environment monitoring, land monitoring, climate change, emergency management and security; (b) a space component ensuring sustainable space-borne observations for the service areas; (c) an in-situ component ensuring coordinated access to observations through airborne, seaborne and ground based installations for the service areas. The infrastructure space component of Copernicus consists of 24 satellites called Sentinels; Sentinel 1-A was launched in April 2014. By the end of 2020, 8 Sentinels are foreseen to be in orbit and over 24 Sentinels will be launched by 2040, providing most of the data needed by the Copernicus services. For the tasks not covered by Sentinels, Copernicus relies on third party missions (Copernicus Contributing Missions).

Since 2012, the Copernicus Emergency Management Service (EMS) is an operational mapping and early warning service, which supports crisis managers, civil protection authorities and humanitarian aid actors dealing with natural disasters, man-made emergency situations, and humanitarian crises as well as those involved in preparedness and recovery activities. As an EU service, the EMS's first priority is responding to national or cross-border disasters in Europe and large-scale disasters outside the EU. The EMS has two main components, Mapping and Early Warning. The Copernicus EMS Mapping Service provides a 24/7/365 Rapid Mapping for high-speed service delivery during crises. In addition, it provides Risk and Recovery Mapping, which is designed for pre- or post-crisis situations in support of prevention, preparedness, disaster risk reduction and recovery activities. The Mapping service follows the Copernicus free, full and open access policy and its products are available on the EMS portal (www.emergency.copernicus.eu). The Early warning components of the EMS provide alerts and risk assessments of floods and forest fires.

IWG-SEM

The IWG-SEM brings together the EU, the UN as well as many national and international organizations and NGOs involved in satellite emergency mapping. The mission of the IWG-SEM is to "Establish best practices between operational satellite-based emergency mapping programmes, stimulate communication and collaboration, support the definition of emergency mapping guidelines, strengthen the sharing of expertise and capacities and review relevant technical standards as well as protocols. Work with the appropriate organizations to define professional standards for emergency mapping." In 2014, the group had around 40 members including AIT, DLR, ITHACA, JAXA, UN-SPIDER, USGS, the European Commission and the World Bank. The IWG-SEM is actively supporting global cooperation in satellite-based emergency mapping and, building on this, also strengthens national and international efforts in disaster risk reduction. It is open to membership by representatives of not-for-profit organizations active in satellite emergency mapping and continuously seeks to strengthen collaboration with relevant organizations and actors in this field. For more details, see http://www.iwg-sem.org.

DLR - Center for Satellite Based Crisis Information

DLR is engaged in developing methods and providing services to support the disaster management and disaster risk reduction based on Earth observation technologies. Since more than 10 years DLR has been operating its Center for Satellite Based Crisis Information (ZKI). It provides a 24/7 service for the fast provision, processing and analysis of satellite imagery after natural disasters, for humanitarian relief activities and civil security issues worldwide. Besides rapid response and crisis mapping, ZKI derives also geo-information products for use in disaster risk reduction, early warning

and reconstruction activities. As the development of new products and the improvement of existing ones are largely user driven, DLR closely works to together with different stakeholders such as national and international relief organizations. It also offers training and consulting for field practitioners, situation center staff and decision makers. Moreover, DLR is also member of the International Charter „Space and Major Disasters“.

NDRCC

The National Disaster Reduction Center of China of the Ministry of Civil Affairs of the People's Republic of China is a specialized government agency which is engaged in information services and decision-making support on various natural disasters. The Center provides on-site survey and assessment for critical natural disasters by collecting, analyzing and assessing disaster information using advanced technology such as satellite remote sensing. The Center also has abundant and rich experience in disaster risk reduction capacity building projects which focusing on high technology application for the government official, technical staffs as well public.

ANNEX 2. Acronyms and Abbreviations

ADPC	Asian Disaster Preparedness Center
AIT	Asian Institute of Technology
APIC	Asia-Pacific International Space Year Conference
APRSAF	Asia-Pacific Regional Space Agency Forum
CAS-TWAS-SDIM	The Chinese Academy of Sciences – the World Academy of Sciences Centre of Excellence on Space Technology for Disaster Mitigation
CEOS	Committee on Earth Observation Satellites
CNE	National Emergency Commission, Dominican Republic
COPERNICUS EMS	COPERNICUS Emergency Mapping Service
COPUOS	Committee on the Peaceful Uses of Outer Space, United Nations
CSSTEAP	Centre for Space Science and Technology Education in Asia and the Pacific
DLR	German Aerospace Center
DMC	Disaster Management Centre, Sri Lanka
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ECVs	Essential Climate Variables
EMS	Copernicus Emergency Management Service
EO	Earth Observations
ESA	European Space Agency
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EU	European Union
G8	Group of Eight
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
HFA	Hyogo Framework for Action
ICIMOD	International Centre for Integrated Mountain Development
IGAD	Intergovernmental Authority on Development (Africa)
IWMI	International Water Management Institute
IPCC	Intergovernmental Panel on Climate Change
IWG-SEM	International Working Group on Satellite Emergency Mapping
JAXA	Japan Aerospace Exploration Agency
LDCs	Least Developed Countries
LLDCs	Land-locked Developing Countries
NDRCC	National Disaster Reduction Center of China
NGO	Non-Government Organization
RESAP	Regional Space Applications Programmes for Sustainable Development
SIDS	Small Island Developing States
UAVs	Unmanned Aerial Vehicles
UN	United Nations
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
UNFCCC	United Nations Framework Convention for Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
UNITAR	United Nations Institute for Training and Research
UNOOSA	United Nations Office for Outer Space Affairs
UNOSAT	UNITAR Operational Satellite Applications Programme
USGS	United States Geological Survey
TBC	To Be Confirmed
TBD	To Be Defined
WCDRR	World Conference on Disaster Risk Reduction
WMO	World Meteorological Organization
ZKI	Center for Satellite Based Crisis Information, DLR