CEOS Working Group Disasters Strategy Paper

Promoting Space Data for Disaster Risk Management

Table of Contents

Executive Summary

The Committee on Earth Observation Satellites Working Group on Disasters (CEOS WGDisasters) advances the strategy of promoting space data for disaster management by improving **access, use and utility**. This furthers its mission to ensure the sustained coordination of disaster-related activities undertaken by the CEOS Agencies and to act as an interface with the community of stakeholders, partners and users committed to disaster risk reduction. This paper explores the implementation of this strategy and it's aligned with the objectives of the working group.

While **hazards** cannot be managed, the **risk** derived from the combination of hazard, exposure, vulnerability and coping capacity can be better managed with a user-centric and data-driven strategy enabling situational prediction and awareness. Desired outcomes such as disaster resilience and sustainable development mean that decisions and actions must be science-informed with increasingly reliable, trusted and open data and data products.

The WGDisasters, which includes more than 120 members from across many nations, agencies and organizations, designs and maintains many of the Earth observation systems that collect, analyze, and disseminate relevant data and practical information applicable to **disaster risk management** (DRM) and **reduction** (DRR). All CEOS agencies can promote space data from satellites **for extreme events**. Some members also contribute airborne and in situ information, including geographic information systems (GIS), and use information and communications technology innovations, research and analysis, applications development, capacity building and specialized services to enhance the value of measurements.

In order for CEOS to design, operate and maintain the current and future Earth observation systems that benefit society it is important that they understand the data and product requirements. Since no single data set can meet these expectations, WGDisasters pilots the ability and demonstrates the value of combining and fusing data that may enhance effectiveness throughout the disaster management cycle, namely for preparedness, mitigation, response and recovery. Furthermore, CEOS works with the Group on Earth Observations (GEO) and multiple partners to make discoverable, interoperable and analysis ready the data from a diversity of environmental sensors and models need to monitor and characterize **systemic disaster risk**.

Consistent with the objectives of WGDisasters, in context where disasters cause significant human, economic and environmental losses that grow with time, such as those from an increasing number of extreme events, and where disaster prevention continues to gain political, economic, and geopolitical importance, the WGDisasters drafted this strategic paper *on* ***Promoting Space Data for Disaster Risk Management*****.**

The WG Disasters objectives are to:

- Support the efforts of **Disaster Risk Management authorities** in protecting lives and safeguarding property by means of satellite-based EO and science-based analyses
- Foster **increased use of EO** in support of Disaster Risk Management
- Support the implementation of the **UNDRR Sendai Framework for Disaster Risk Reduction**, and in particular contribute to its Priority One, "Understanding Risk"
- **Raise the awareness** of politicians, decision-makers, and major stakeholders of the benefits of using satellite EO in all phases of Disaster Risk Management

The paper has seven sections and an annex containing the *WG Disasters Terms of Reference*.

I. ***Introduction*** presents the working group vision and the objectives of this strategy document. It addresses the new abilities with respect to measurement, and the increase in volume of available data, while identifies the major changes in built and natural environments, relative to impacts of natural hazards. The Introduction also states the purpose of the document, which is to address how the CEOS WG Disasters can make a meaningful contribution to international activities, tying satellite earth observation to DRM. Given the impressive opportunity, the increased use of satellite Earth Observation (EO) holds promise for the risk community when the number of observing sensors more than doubles over the coming decade.

II. ***Stakeholder / Partner Engagement*** defines the phrases Stakeholder and Partner in the context of this document and, in general, for the WG Disasters community. It reminds us that it is a CEOS objective to create and strengthen partners that encourage the open use of EO for disaster risk reduction and location (geospatial) information useful and used for DRM. In order to help realize the benefits of EO and clarify the strategic direction of CEOS' DRM efforts and investments, this section stresses that consistent long-term engagement of the CEOS community of practice with stakeholders and partners is required. Where appropriate, WG Disasters works with member agencies to establish and strengthen intergovernmental coordination forums composed of relevant stakeholders at the national and local levels, such as national and local platforms for DRR (such as with Sendai and GEO). This serves to gain an understanding of their fundamental and practical requirements for Earth observations prior to taking implementing steps. This in turn helps ensure meeting objectives and sustaining results achieved. In this sense, the section address the intent of engagement, i.e. the motivation and mechanisms of engagement, with a forward-looking perspective, arriving at an understanding of what is possible and where the gaps can and should be addressed.

III. ***Open and Free Data Access*** addresses how CEOS agencies approach the access to relevant data today and how it may change in the future. This includes attention to important disaster variables, the available open data of different spatial and temporal resolutions, and applicable latencies of date critical for disaster management and data-driven decisions. In some cases, open data may be licensed, commercial data, but it is open because it is easily accessible using defined procedures. This section reminds the reader to consider the full disaster risk management (DRM) cycle from routine observation and monitoring, to early warning, for providing situational awareness during response and throughout recovery phases. In this way, WGDisasters promotes EO data's requirements for risk and resilience assessment, for planning and mitigation, for characterizing the extent and severity of impacts, and for guiding relief and the post-disaster restoration. Specific attention focuses on the role and value of open and free data; while distinguishing between *open* versus *open-and-free* data. The section also refers to current and evolving business models for open/restricted and commercial data as they apply to the WG Disasters and, more broadly to growing communities of public and private practice. The section reminds the reader that over the last decade, there has been a proliferation of free and open EO data sets coming

from mostly the public-sector funded satellite missions, and international collaboration initiatives (International Charter, Copernicus Emergency Management Services, Sentinel-Asia, US Civil Space agencies, the Coordination Group for Meteorological Satellites (CGMS), and various Group on Earth Observation (GEO) communities-of-practice). Finally, some of the issues and opportunities facing CEOS agencies currently limiting data products to experienced customers and science experts, but not directly usable or interpretable for uptake by new and emerging adopters, users and stakeholders in EO disaster application, is addressed. The latter, acknowledges the strategic importance of promoting open data as a social good and increasing the engagement between CEOS and non-CEOS agencies with data furthering shared DRM objectives.

IV. **Licensed and Commercial Data Access** describes the meaning of licensed and commercial data sets, with various restrictions and opportunities, within the scope of WGDisasters objectives and role. This section explores the current and evolving efforts required to refine and streamline the procedures for requesting, ordering, and accessing data by the broader DRM community. The paper discusses how CEOS agencies, individually or collectively, consider the pros and cons of switching from the long-standing data "purchasing model" to a "subscription-based model." Some lessons learned and success stories excerpted from pilot and demonstration projects of WGDisasters show the relevance and scalability of access to currently licensed and commercial data to the larger DRM community. Although commercial exploitation of EO data is often an obstacle to public good served by EO-based disaster management, the section addresses an alternative view held by some CEOS agencies that commercial exploitation, and in some instances national economic or security interest, is the basis for funding and launch of a number of EO satellites. It is also suggested for providers of commercial data that the CEOS objectives and data strategy consider charging only for ordering of new acquisitions and first data access, while allowing free and unrestricted access to data from archives and background missions.

V. ***Applications / Services / Exploitation Platforms*** addresses the requirements and policies of CEOS and those of the disasters community to have optimized tools and efficient practices to collect, access, dispense and use non-sensitive EO data and information. This section covers aspects of promoting near –real time access to and the sharing and use of reliable data, recognizing the strategic need for establishing new and strengthening existing data services and data exploitation platforms. Driven in part, by an unprecedented increase in EO data, including the "big data" attributes of volume, velocity, veracity and variety, provided by today's satellite missions and those anticipated over the coming decade. WGDisasters notes that this data abundance entails a paradigm shift relevant to DRM in the way satellite EO data are accessed and used, and how information systems, enterprises and architectures being advanced by CEOS will accelerate the "bring your code to the data" approach. Promoting the power of data for DRM also demands transitioning research into applications and infusing innovative technologies into practice. The section discusses how data tools and platforms can enable spending less time managing and processing large diverse datasets and more time integrating, interpreting and analyzing disaster data from multiple sources. This section also highlights some of the existing data access and processing services/platform approaches of CEOS agencies, including thematic exploitation platforms (TEPs), Data cubes, and several others. A substantial part of this section is devoted to

assessing how cloud migration trends affect the working group objectives, as code and algorithms move close to the data in various cloud environments. Given the ever-increasing level of maturity of CEOS engagement with the commercial sector, particularly with respect to Analysis Ready Data (ARD), this section discusses the benefits for the DRM sector being a catalyst, testbed and use case for advancing the future observing strategy.

VI. ***Major Gaps in DRM Observations and Services*** identifies gaps and impediments of a wide spectrum of types and origin in the access to EO data, including political, infrastructural, technological, and administrative and includes a link to capacity development. All these restricting reasons are potential limits to the usefulness of data and derived products, or their timely availability in near-real time, for disaster detection and early warning. The section finishes with a list of measures to identify the aforementioned gaps in a given situation as part of a DRM observations and services gap analysis.

VII. ***Conclusion*** condenses the key aspects addressed in the previous sections, while summarizing the main findings and the path forward. CEOS and the WGDisasters strategic role confirms the main objectives of the working group relative to data access, use, and utility and reasserts practical actions and workplans to achieve desirable outcomes. Conclusions incorporate the feedback from an internal survey on the working group strategic role. Special attention given to promoting space data for implementation of Sendai Framework furthers its targets, in particular, Priority 1: “Understanding Risk.” Promoting the integration of CEOS data supports implementing Sendai Guiding Principles of requiring a multi-hazard approach and risk-informed decision making based on the open exchange and dissemination of non-sensitive data, as well as on easily accessible, up-to-date, science-based information. CEOS WG Disasters has not addressed Sendai principles of inclusion and compression with disaggregated data involving socio-economics factors nor inclusive traditional knowledge. The WGDisasters implementing approach through pilot and demonstration activities can evolve to address the UNDRR Global Risk Assessment Report (GAR) and Framework (GRAF) in support of Sustainable Development Goals (SDGs). The role of the working group in supporting, by means of satellite-based EO and science-based analyses, the efforts of addressing Sendai Indicators, Targets and Principles as well as the practical metrics of DRM authorities in the utility of EO in augmenting knowledge for protecting lives and safeguarding property. Strategies fostering and raising awareness of major stakeholders highlights benefits of using satellite EO in all DRM Phases.

I. Introduction

In recent years, CEOS has become increasingly aware of the need to make satellite Earth observations (EO) more relevant in disaster risk management (DRM) efforts and to ***improve the access, use and utility of the data*** for disaster risk reduction (DRR). While satellite remote sensing has been known and used as a tool in disaster management and sustainable development for many years, advances have driven the urgency to re-examine how space data can inform risk, rather than simply documenting hazards, which necessitates a fresh look at the strategic implications for CEOS going forward.

Reflecting on the role and contribution of CEOS over the years, it is notable to recall that in November 2013, at its 27th Plenary Meeting, members approved a comprehensive, coordinated observation strategy to support disaster management efforts. Satellite remote sensing was becoming increasingly attractive due to its cost effectiveness, short temporal orbiting and large area of coverage. Simultaneously, among the disaster management community there was a growing awareness that satellite deployment was limited by a number of factors, including the divide between developed and developing countries, data accessibility (especially high resolution and radar-based imagery) and technological limitations. The turning point came when acknowledging that earth observation, science research, and viewing hazards as equivalent to disasters were insufficient to understand and address systemic disaster risk. In 2015, the world adopted the *Sendai Framework for Disaster Risk Reduction 2015-2030*, a global agreement to reduce and seek to prevent disaster risks across the globe. In particular, the framework identified *earth system observations and earth system science* as solutions to decrease the complexity of multi-hazards, and incorporated exposure, vulnerability and coping capacity to better address systems thinking and guide action. Recognizing the increasing impact of disasters, their complexity in many parts of the world, and the call for satellite data to play a strategic role, CEOS established a **permanent Working Group for Disasters** (WGDisasters).

CEOS was an active participant in the formulation and adoption of the Sendai Framework and in subsequent years advanced its implementation. In 2019, satellite data made a substantial contribution to the Global Assessment Report on DRR (GAR) and enabled the systems approach articulated in the Global Risk Assessment Framework (GRAF). Within the WGDisasters, this has manifest in more global, practical and inclusive workplans that reflect a growing shift toward risk management and resilience development. Measureable progress is increasing data accessibility, embracing a broader and diverse range of pilot and demonstration projects, and expanding efforts across the disaster management cycle.

The main goals that led CEOS agencies to create the WG Disasters and increase risk-related activity are threefold:

- To support the protection of lives and safeguarding of property;
- To foster increased use of EO in support of DRM
- To raise the awareness of politicians, decision-makers and major stakeholders of the benefits of using satellite EO in all phases of DRM.

In October 2019, at its 33rd Plenary Meeting, CEOS adopted its new WGDisasters Terms-of-Reference (TOR) in support of national and regional priorities as well as the disaster risk interests of stakeholders and partners. This reaffirmed WGDisasters role across the broader CEOS initiatives and communities of practice, with the Group of Earth Observations (GEO), and the Sustainable Development Goals (SDGs). It also documented the CEOS members' commitment to coordinate activities and make best effort to align

objectives and plans with implementation of the Sendai Framework. This milestone elevated the strategic significance of promoting space data and the actions to strengthen social and economic resilience and ease the negative effects of climate change and the growing concerns from disasters, whether from natural hazards or human factors.

While remote sensing systems have been playing a growing role in disaster management and risk and resilience assessment in such areas as flooding, cyclones, drought, earthquake and tsunami, current CEOS WGDisasters workplans have focused on a few hazard themes and use cases. WGDisasters Pilot projects have included global flood monitoring, volcano-activity monitoring in the Americas, local landslides in regions of high susceptibility and seismic hazards around specific active faults. These pilots span periods of typically 3-year duration with specific deliverables and outcomes of interest to stakeholders and sponsors. WGDisasters has also explored the data needs for disaster recovery and tested a novel multi thematic Recovery Observatory approach.

The long-term vision for CEOS action to support DRM is a contribution that is:

- Global in scope, building on strong involvement at local/national or regional levels;
- User-driven (i.e. defined against user information needs and based on the engagement of the diverse user communities involved in DRM);
- Risk-based, incorporating hazard, exposure, and vulnerability to support decision making to reduce and better manage risk;
- Full-cycle (i.e. address mitigation/preparedness, warning, response/recovery, etc.);
- Multi-hazard approach, addressing cascading events and compounded risk;
- Taking account of all relevant EO based capabilities and integrating them within a decision-making framework; and
- Sustainable through partnerships.

The Pilots and Observatories have tackled practical issues of why and how to exchange or share non-sensitive data (especially from high resolution and radar-based sensors) among CEOS agencies and with select partners. A new Flood Risk Pilot in formulation builds on lessons learned from the earlier Flood Monitoring Pilot and incorporates flood partners from communities in the Group on Earth Observation (GEO) and the Coordination Group for Meteorological Satellites (CGMS). Among pilot objectives is examining the value of monitoring hazards and impacts in locations where other observation networks are impractical. In two cases, Pilot projects for volcano, seismic hazard and Recovery Observatory (RO) sectors matured in their readiness for use and extensibility to the point that CEOS approved follow-on Demonstrator projects.

By way of Demonstrators, the WGDisasters strategy aims to be more user-centric, integral to CEOS-wide priorities, support satellite continuity and technology advancements, and increase sustained service to stakeholders. Demonstrators are creating and establishing a lasting contribution of satellite EO to their sectors, showcasing how Pilot initiatives can lead to proto-operational activities within the CEOS planning framework and improve the integration of risk factors into their work plans.

The Volcano Demonstrator has taken a regional experience in Latin America to a global network of monitored volcanoes. The Seismic Demonstrator expands Pilot practices to a global community of seismic science users. The Haiti RO Pilot allowed user and practitioners to explore recovery products, leading to a RO Demonstrator that implements the concept of a “Generic RO”. This generic capability

promotes the global replication and reproduction of a specific family of observations and data products in support to Recovery in a sustainable manner. Finally, the Landslide Demonstrator aims to bring demonstrated multi-sensor detection and monitoring practices to a global community of users including public and private sectors at the national and local levels. By establishing and maintain the EO-based observatories Demonstrators within a critical window of time after major disasters, the WGDisasters is working closely with key relief, recovery and development partners to assess impacts and inform intervention of actors and decision makers.

The strategic issues of data access, use and utility are closely tied to the rapid growth of international satellite assets and the associated pace of enabling technologies and applications. From roughly 150 EO satellites in 2008, to over 350 in 2018, the number of observing sensors more than doubled in a decade. This expansion in number along with resolution capabilities will accelerate at even a faster pace over the next decade. Larger satellites continue, but increasingly replaced by more flexible, cost effective and easily deployable constellations of smaller satellites, offering greater reach and scope, and greatly improved revisit time. Whereas a decade ago, few satellites offered very advanced capabilities with sensors other than high-resolution optical or medium resolution multispectral sensing, today, there are scores of satellites offering complex data (with enhancements across all attributes of spatial, spectral, temporal, radiometric and geometric resolutions) requiring advanced processing and interpretation skills. Ironically, this enlarged offering brings an added complexity: choice. Not all sensors are equal; many applications require multiple sensors and different data sets. A whole research field has emerged in how to fuse, more properly and expertly, data for various DRM and related applications. The CEOS approach to promoting data for DRM will there need to be agile as the offering put forward by satellites has never been richer and more diverse, or have the potential to be more readily available.

The potential contributions of space observations for DRM:

- Risk Identification (Identifying all the risk factors; all the possible causes for damage and loss)
- Risk Analysis (Analyzing the risk; assess and measure the potential for damage and loss)
- Risk Response (Determining what to do; either assume, transfer or reduce the risk)
- Risk Control (Implementing mitigation or controls to reduce or transfer the risk)
- Risk Monitoring (Selecting a method for monitoring results and putting it in practice)

Strategies and tactical work plans across CEOS are evolving to make data, tools and skills available to more people through open data and licensing policies, easier-to-use-training, capacity development, and access to exploitation platforms or online tools tailored to big data processing and visualization. This complements work to improve communication capabilities to ensure information is translated into geospatial intelligence i.e. location knowledge, which conveys acceptance and understanding of disaster risk. The CEOS WG Disasters contributes to these international activities by tying the promotion of space data to DRR indicators. It aims to summarize for DRM stakeholders and satellite managers alike the impressive practical opportunities increased use of satellite EO holds for the risk community.

The growing use of EO for disaster resilience introduces a sustainability objective to DRM. Resilience increases if we have an earlier understanding of risk and therefore early access and use of satellite EO to better understand past impacts, and better utilize data to predict and prevent future damage or losses is of considerable interest. Timely access to the right data, at the right time in the right location that is trusted, reliable and made ready for use can support actions and policies for disaster resilience.

It is not sufficient to provide data and images and expect risk reduction and resilience to follow; the EO community works closely with stakeholders to build relationships among decision makers and actors while co-developing proven and effective satellite missions, technologies, information systems and decision tools. Therefore, the data promotion strategy of WGDisasters incorporates explicit requirements and projects to engage stakeholders and partners.

WGDisasters notes that this strategic perspective of promoting open data advocates for considerable work and the need to target investments and resources. Processes requiring open access to EO from a variety of sources over various times and spatial scales requires considerable planning and dedicated follow up to the pilot, demonstrator, observatories and platforms to transform project results into operational practice. Increasing volumes and variable rates of relevant non-sensitive data mean that EO for DRM strategies must consider efficiency of data practices, standards and harmonized information systems. Strategic implementation puts workplans into action so that EO for DRM includes inventorying capabilities, assessing and communicating effective practices, and promoting the most relevant standards and essential data exchange mechanisms or sharing approaches.

The strategy of space data promotion necessitates creating and building public-private partnerships, aligning with and strengthening existing practices and assisting in mainstreaming of improved methods. This raises the recurring question of who will finance and who will execute these activities and how will resources target competing needs that exploit emerging opportunities. Consolidating the distribution and delivery process for relevant EO data (from remote sensing technologies supplemented by earth surveying techniques) as well as the fusion with other data introduces considerable expansion potential for the number practitioners and variety of partners.

II. Stakeholder and Partner Engagement

CEOS seeks to encourage and understand the use of EO to support the diverse needs of stakeholders and partners for DRM and across the earth observation community. Collectively, the desired outcomes include risk reduction and prevention for resilience as well as the continuous technological and economic advancement. In helping to realize the benefits of EO and clarify the strategic direction of CEOS' DRM efforts engagement is required with stakeholders and partners.

WGDisasters defines a **stakeholder** as a beneficiary, in the broadest and most inclusive sense, of CEOS activities in DRM. Stakeholders come from many diverse areas, cultures and backgrounds including government and non-governmental organizations, civil-society and humanitarian bodies, academia, civil protection, industry, commerce, indigenous and tribal peoples, local communities and individuals. A **partner** is an individual or entity in direct receipt of data, data products (models, maps and related applications and tools) who may collaborate, use or add value. For example, a nation's space agency is a stakeholder with interests in supporting scientific discovery, business, and societal benefit through the development and launch of EO missions, which support individual partners, such as emergency management organizations or humanitarian relief groups who in turn utilize reliable scientific outcomes or new practical applications that assist in their risk management decisions and interventions.

Stakeholders and partners in EO for DRM are often associated with organizations and groups focused on science advancement as well as technical data interoperability and standards. With a strategy to open access and use, which also embraces emerging information technologies and capacity development, an early adopter community will emerge among non-scientists to redefine the community-of-practice and expand the market for EO in DRM. Other stakeholders and partners focus on product generation and providing related services and as barriers lower to data access and use, new enterprises can expand. A growing number of international or agency partners are actively involved in disaster risk assessment and this will likely increase the update of EO data through engaging humanitarian relief and health organizations. Others risk reduction initiatives link with climate and ecosystem impacts, such as the Space Climate Observatory (SCO) initiative, or with sector interests in disaster resilient agriculture, water, energy, transport infrastructure. There is potential for Disaster risk reduction initiatives in just about every sector of development and humanitarian work and the CEOS WGDisasters' strategy can strive to promote utility of data should penetrate as many crosscutting initiatives as possible.

Examples of key international and intergovernmental bodies include:

- United Nations Office for Disaster Risk Reduction (UNDRR),
- Group on Earth Observations (GEO)
- United Nations Global Geospatial Information Management (UN-GGIM),
- United Nations International Committee on GNSS (UN ICG),
- International Financing Institutions (IFIs) including the World Bank
- International Association of Geodesy (IAG)
- World Meteorological Organization (WMO)
- United Nations Development Programme (UNDP)
- United Nations Office of Outer Space Affairs (UNOOSA)

Successful and sustainable engagement focuses on partners and stakeholders who can integrate EO with their efforts, mainstreaming practices and quantify DRR. Within the key stakeholder organizations, there exist a multitude of entities, including technical working groups, committees, consortia, and the like, whose many programs, projects and activities align with CEOS to advance demonstrable DRR. In many cases, these stakeholders have structures and mechanisms that translate global efforts to regional and in national indicators. Since disaster impacts and decisions should be user-centric, the CEOS and WGDisasters strategy must scale from global to local practitioners.

Collaborations with these partners and stakeholders, at all scales and targeting multiple locations and sectors, emphasizes understanding the fundamental requirements of EO necessary to meet the needs of partner users and information brokers. Since WGDisasters are often best effort and resource constrained, and disaster risk is inherently a complex social issue it is through stakeholders help and partners trust that CEOS efforts will ensure many of the needs are met and sustainable.

In order to understand how communities can incorporate and use data, CEOS must work (and even more, co-work and co-build) with partners and stakeholders to assess their near-term needs and the ability of these communities to utilize EO data. Through these engagement efforts and collaborative projects WGDisasters can explore what is possible, uncover where some of gaps in understanding or capacity, enabling CEOS agencies to derive missions and applications to meet real DRM needs. In some cases, CEOS agencies may design or modify satellite missions and technologies to help meet current needs while in others there may be opportunities to identify new requirements for future missions serving EO for DRR.

In these engagement efforts, CEOS must recognize the complex multihazard and systemic nature of risk as adopted and articulated in the Sendai Framework and key to the Sustainable Development Goals. Not all hazards are alike, just like the nature of exposure, vulnerability and coping capacity varies from community to community and region to region. It is in the interest of CEOS to understand the specific regional, national and local needs of stakeholders and partners to optimize the targeting of resources and work plans. For example, the needs of partners leveraging EO for geodetic observations may be unique versus those of other hazards, such as fires and floods -- therefore, through pilot, demonstrator, and other collaboration efforts WGDisasters can be convene partners to characterize and document needs in specific use cases, locations and thematic areas. As introduced earlier, Pilot projects that focus on a key area of interest and the exchange or sharing of selected data sets in exploratory ways to test feasibility can broaden to Demonstrators projects that show how easier, routine access to the data would provide a sustained utility and lasting impact on disaster management.

Communication and advocacy with stakeholders is also pivotal to the development of actionable, usable EO-derived information and the utility of the distilled knowledge. WGDisasters recognizes the need to convey clearly effective capabilities as well as any limitations, and encourages systematic external user-validation, to maximize transparency and confidence in the results obtained.

With a broad and growing community of non-traditional and potential partners in disaster risk, who could benefit from the incorporation of EO in DRM, CEOS agencies could explore expanding outreach and education beyond those in hazard risk to networks involved in operational, financial and strategic risk. Many in CEOS as well as in these risk areas have yet come together and neither may realize the potential for EO in risk identification, analysis, response, control and monitoring. While some of these are clearly beyond the scope of CEOS, scientific research interests or touch on commercial interests there are opportunities to engage partners in risk. For example, the WGDisasters has engaged with World Bank, financial development and re-insurance to promote access and novel use of data in areas of economic security. The close alignment of WGDisasters with the CEOS group on capacity development, WGCapD, along with other national and international development activities is crucial to successful engagement with potential partners, working together to broaden the use of EO for DRM

Through workshops, symposia, and other outreach, WGDisasters works with stakeholders and partners to identify other communities of potential that could benefit from EO for DRM. In collaboration with other CEOS working groups, such as those in capacity building and information systems, stakeholders, and partners, WGDisasters develops opportunities to educate and train new potential partners on the relevance of EO data for filling DRM needs. The working group recognizes the increasing role of the private sector and, as such, engagement is expanding with specific sector stakeholders that will stimulate increased economic and business development needed to transition service delivery when and where appropriate.

Efforts to learn from partners, sustain engagements, and apply EO to DRM necessitate effective communication of the benefits to earn stakeholder advocacy for current and future missions. Stakeholders need to recognize and champion the value of relevant satellite mission data when access, use and utility helps society in reducing disaster risk, improving response, and helping foster greater resilience.

In addition to understanding partner needs, sharing and communicating the partner's use of EO data and utility in decisions, actions and outcomes is important. This is true, whether EO use is direct or as

part of integrated risk assessment frameworks that include combinations of physical and socio-economic models and algorithms, as long as value to risk reduction is piloted and demonstrated. Consequently, the objectives of stakeholder need to incorporate awareness raising of specific, tangible benefits and outcomes from the use of EO to support their ability in further champion for the availability of free and open data, reduced data latency, greater access to processing tools, the sharing of research results and power of EO-based applications.

Successful demonstrations of societal benefit from partner's use of EO for DRM elevate the strategic significance of working with stakeholders and collaborators their lasting roles in advocating for policies and programs enabling continuity of satellite constellations that support situational awareness, science-informed decisions making and actionable knowledge across the disaster management cycle.

The International Charter: Space and Major Disasters

The International Charter provides a unified system of space data acquisition and delivery to those affected by disasters. Space agency members commit resources to support the provisions of the Charter, which pre-defined authorized users can activate. Success over the last decades has led the Charter to broaden access to satellite imagery for disaster response to any national disaster management authority in need, through its Universal Access policy.

III. Open and Free Data Access

Over the last decade, there has been a proliferation of free and open EO data sets coming predominantly from public-sector funded satellite missions, mainly in the US, Europe, Asia and partners, but also from international collaboration initiatives such as the International Charter, Copernicus EMS, Sentinel-Asia and US Civil Space agencies.

Vast amounts of global data from environmental satellites and from ground-based, airborne and seaborne measurement systems used to derive key information to aid public authorities in managing disaster risk. Governmental agencies such as NASA, NOAA, USGS, ESA, and EUMETSAT provide global, non-licensed environmental satellite data in order to meet this need, and understand our dynamic Earth. They deliver data daily, powering forecast models, as well as watches and warnings for all types of oceanic, atmospheric, and space hazards and/or conditions. These critical satellite Earth observations and other essential environmental information are vital to support various phases of the disaster management cycle including preparedness, all hazards response and recovery,

Sentinel-Asia

The Sentinel Asia initiative is an international collaboration among space agencies, disaster management agencies, and international agencies for applying remote sensing and Web-Geospatial Information System (GIS) technologies to support disaster management in the Asia-Pacific region. Its aims include:

Improve safety in society by Information and Communication Technology (ICT) and space technologies;

Improve the speed and accuracy of disaster preparedness and early warning.

and the protection of critical infrastructure and natural resources. For example, this includes everything from the atmosphere, to precipitation events that provide water for agriculture and communities, to natural disasters such as droughts and floods, to the oceans. Open data is also extensively used to produce official risk assessments and models of the environment such as climate trends and sea level change. As mentioned, aircraft, watercraft, and ground measurements supplement the space data to assess the disaster risk in a more comprehensive manner.

Copernicus Emergency Management Service

The Copernicus Emergency Management Service (EMS) uses satellite imagery and other geospatial data to provide free of charge mapping service in cases of natural disasters, human-made emergencies and humanitarian crises throughout the world. The Copernicus EMS Mapping provides services during all phases of the emergency management cycle and always free of charge for the users.

Copernicus Emergency Management Service (Copernicus EMS) provides information for emergency response in relation to different types of disasters, including meteorological hazards, geophysical hazards, technological or human-caused hazards and other humanitarian disasters as well as prevention, preparedness, response and recovery activities. The Copernicus EMS is composed of an on-demand mapping component providing rapid maps for emergency response and risk & recovery maps for prevention and planning and of the early warning and monitoring component, which includes systems for floods, droughts and forest fires. It includes the European and Global Flood Awareness Systems (EFAS, GloFAS) as well as the European Forest Fire Information System (EFFIS) and the Drought Observatory for drought early warning for Europe and the globe.

US Civil Space Agencies

NASA, NOAA and USGS, in collaboration with many partner agencies, manage the widest integrated system of satellite, airborne, and in situ observations providing free and open data available for earth system science and disaster risk management.

Routine and specialized data and data products (many in near real time, archived and available as web-enabled services and GIS products) as well as predictive models, maps and decision tools are readily available. This supports the full DRM cycle (mitigation, preparedness, response and recovery), international disaster warning and advisory centers, global navigational satellite networks, and search and rescue. Collaborative ventures include the international space station.

The US civil space agencies, in collaboration with many partners address multi-hazard, exposure and vulnerability decision support (weather, climate, water and ecosystems, health and air quality, ocean and geo-hazards, and other natural and human-induced socio-economic elements). Associated data, hazard and disaster centers provide free global access, catalyzing use and utility. Dedicated research and technology programs accelerate applications and enable capacity development.

Compared to commercial datasets, the spatial resolution of open data is typically coarse, but the temporal frequency is much higher, allowing for rapid revisit of a large imaging footprint. These specifications are ideal for monitoring the development and progression of large-scale hazards like cyclones and droughts, as well as environmental health indices such as land change and ocean color.

Multiple platforms and portals freely serve processed satellite data. One of which is the USGS Hazards Data Distribution System (HDDS Explorer), an event-based interface that provides a single point-of-entry for access to remotely sensed imagery and other geospatial datasets as they become available during a response. The imagery hosted on HDDS includes data from public domain sources, along with licensed imagery from many other partners and agencies. Due to license provisions, some of the contributed imagery may be subject to data access and use restrictions.

Further, there exists a number of no-cost, information and derived product services with the purpose of transforming satellite data into actionable information. For example, the Copernicus Emergency Management Service and the collection of products from the US Civil Space Agencies support a diversity of operational information and mapping services before, during and after disasters.

IV. Licensed and Commercial Data Access

By contrast to free and openly available EO data, other EO resources are available under an individual license text. These are often data from very-high spatial resolution sensors, both in the optical and the SAR domain. Both commercial providers and CEOS Agencies distribute these data under a various set of frameworks and conditions.

VHR and HR data made a major breakthrough for the application of remote sensing to Disaster Risk -Management. Higher-resolution imagery can resolve individual elements at risk such as buildings and transport infrastructure or more accurately can delineate land cover characteristics or represent elevation information. In synergy with medium resolution data, high resolution improves monitoring capabilities when enabling on demand acquisitions and/or the setting of various operating modes.

The WG acknowledges that some CEOS agencies and data providers offer data on a commercial basis for operational/non-research purposes. While commercial exploitation of EO data can be an obstacle to EO-based disaster management, it may on the other hand provide the basis for the launch and continuity of an increased number of EO satellites benefiting DRR. Providers of commercial data could consider to charge only for ordering of new acquisitions and first data access, but allow additional users free and simpler access to data from the archive, where possible – at least for scientific purposes.

"Background Mission" Concepts

Utilization of EO data for DRM, as well as related earth system science are more robust through effective "background mission" concepts and practices. Background mission means that the area of interest would be systematically collected (i.e. every orbit or some predetermined schedule such as every descending orbit). From a disaster perspective, there is no new additional needed tasking. The data is collected. There have been repeated suggestions from scientists to use such concepts to regularly image "hazard hotspots", such as selected volcanoes or vulnerable urban areas at intensive risk (seismic risk, subsidence, coastal flooding etc.). While it is not always possible to implement or improve a "background mission" within the lifetime of a satellite mission, this capability is important for the design of new missions to come. The WG Disasters could provide recommendations for background acquisition strategies supporting EO utilization related to DRM.

Several CEOS agencies provide data free of charge (or for an expense allowance) for the purpose of research or scientific exploitation. In this case, there is a crucial, but sometimes unclear, boundary between scientific demonstration of the utilization of EO data for the purpose of DRM on the one hand, and operational use or routine monitoring on the other hand. For both scientific users and data providers this distinction is not always straightforward. Usually data providers ask an outline or proposal text by scientists to be able to classify their objectives and take a decision about support. Against this background, it could be wise to implement efficient and straightforward systems for science access.

The WG Disasters continues to make available licensed data from different EO sensors in a collaborative approach in order to support groups of scientists in the frame of international demonstrator projects as well as GEO's Geohazard Supersites. However, it may be prudent to give more attention to supporting sites and projects with high visibility and suitability for demonstrating, at an international level, the synergistic value of the given EO data, ideally with scientists from several countries involved. While scientists usually tend to request data for their individual study areas, respectively, the CEOS WG might decide to follow a more targeted approach. Some agencies operate their own individual science support systems, so especially for these agencies the projects and sites supported in the context of the CEOS WG need to have a notable value-added contribution to the organization.

V. Applications, Services and Exploitation Platforms

As stated in the Terms of Reference, WGDisasters "acts as an interface between CEOS and the community of stakeholders and users involved in risk management and disaster reduction". This includes contributions from sister communities such as the CGMS satellite constellations and growing number of smaller satellites from the private and academic sectors. In this instance, it is vital that the

> *"There are today many opportunities to progress in using satellite-based Earth observations for disaster risk management. These opportunities are allowed by initiatives of the space sector, which has been developing an unprecedented Earth Observation infrastructure.*
>
> *Dedicated dissemination and utilization strategies for such record amount of Earth Observation data should be considered. This is exactly where the support of space agencies arises, introducing concepts of moving algorithms and codes close to data, contrary to past practices that will soon become obsolete due to limited local storage and processing capacities. The Sentinels come along with web-based data dissemination mechanism (including collaborative ground segments etc.) like the Copernicus Open Access Hub, the Sentinel Product Exploitation Platform (PEPS) of CNES as well as the development of processing platforms such as the ESA Geohazards Exploitation Platform, with numerous hosted processing services for geohazards applications (Foumelis et al. 2019). This constitutes a radical change in working procedures of Earth observations scientists and engineers, as less time is required to data management and processing, so that more efforts can be dedicated to the integration of different datasets, the interpretation of the observed phenomena, and the development of new algorithms to gather hazard-relevant information."*
>
> Le Cozannet, G., Kervyn, M., Russo, S. et al. Space-Based Earth Observations for Disaster Risk Management. Surv Geophys (2020).

CEOS WG data strategy identifies understanding when and how Earth observations are captured, integrated and consumed by the DRM community and communicate this knowledge back to member agencies. It must also serve as a proving ground and provide test bed inviting partners and catalyzing new application technologies, services and exploitation platforms that could support future observing architectures and new observation strategies. Ever increasing data volumes of satellite constellations also call for multi-sensor analysis ready data (ARD) that address some of the growing technical, time, and cost burdens for processing. The promotion of space data is therefore closely dependent on applications, services and exploitation platforms that increase value, reliability and ease of uptake of Earth observation products into existing and future DRM decision support systems.

The requirement for current and new services or exploitation platforms are driven by unprecedented increases in free and open Earth observation data and the viability of frontier technologies in information processing and new media. In recent years, satellite EO missions from nearly all CEOS members, whether open-and-free or at best open, have tremendously evolved in terms of unprecedented coverage and quality of data.

CEOS members have both strategic opportunities and challenges with the increasing volumes, velocities and diverse varieties of measurements and formats. With hundreds of sensors and instruments, the growth in data abundance among CEOS agencies, CGMS and other providers, is demanding a paradigm shift in the way that satellite EO data is accessed and exploited, replacing local data downloads, which now exceed local data storage and processing capabilities, with a “bring your code to the data” approach. It also demands new advances that enable EO specialists and DRM personnel to minimize time managing and processing datasets and instead increase the benefit from integrating and interpreting observations from multiple sources.

New Information and Communications Technology (ICT) developments such as cloud processing environments and innovative information extraction techniques (data mining and machine learning) are maximizing the benefits of these remote-sensing capabilities and turning promising data into operational DRM information. The approach of cloud processing environments and services is expert use by scientific teams for the extraction of EO-based information, producing data and products of type more readily to use by decision makers. Such methods help raise awareness (especially in developing countries) and achieve greater acceptance and earlier adoption of EO techniques and derived products by the DRM community. Among the means to abstract and aggregate EO data EO for disasters is the Open Data Cube. Such structures provide an open and accessible exploitation architecture through which stakeholders in a given region of interest can seek to increase the value and impact of EO satellite data. Further work is

Examples of available services, processing and e-collaboration environments for DRM purposes:

- On demand product generation (e.g. via the Copernicus Emergency Management Service for selected emergency situations)
- Processing environments with numerous cloud-processing services for geohazards applications.
    - For instance, ESA contributes in the CEOS WG Disasters with the ESA Geohazards Exploitation Platform (GEP), which is the main pillar of the Geohazards Lab activity and supports the WG Disasters thematic activities such as the Landslide Pilot and the Volcano and Seismic Hazards Demonstrators.

underway to evaluate the sustainability and continuity of this and other platforms as well as to establish the necessary capacity development for practical use in DRM or other applications. WG Disasters identifies ways to maximize the impact of such environments and, critically, advance how they overcome challenges where national and local data bandwidth have prevented effective exploitation of EO data for DRM in the past.

Examples of increasing open data volumes

The European's Copernicus observing programme, coordinated and managed by ESA, with Sentinel-1 and Sentinel-2 satellites are providing free and open imagery at 10- to 30-meter spatial resolutions. Sentinel-1 carries C-band synthetic aperture radar (SAR) sensors for all-weather imagery in a global fashion every 6 to 12 days. Sentinel-2 is able to cover all land surfaces of the globe every five days, providing multispectral data of high radiometric quality.

The NASA/USGS Landsat program is the longest-running enterprise for acquisition of satellite imagery of Earth. Also known as the U.S. Sustainable Land Imaging program, Landsat, has provided free and open multispectral imagery for over 40 years and is committed to an expanding fleet over the coming decade. Landsat 8 added land imaging and thermal sensing with imagery at 15m, 30m and 60-100m resolutions, depending on spectral band. Landsat 9, scheduled for launch in 2021, will continue the critical record of land surface monitoring.

Together, the Sentinel and Landsat missions can provide historical records over the last 10 years as well as near real-time (NRT) observations. NASA's Land, Atmosphere Near real-time Capability for EOS (LANCE) supports users interested in monitoring a wide variety of natural hazards and technological hazards, such as wildfires, floods and oil spills, from a broad constellation of instruments and missions. Most data products are available within 3 hours from satellite observation. NRT imagery and products are generally available 3-5 hours after observation.

The NASA-ISRO Synthetic Aperture Radar mission, NISAR, is a joint project to launch in 2022 with a dual-frequency synthetic aperture L- and S-band radar sampling earth every 6 days, providing free- and open data for measuring natural hazards such as earthquakes, tsunamis, volcanoes and landslides and accessible within hours in the case of disasters.

New operational weather satellites contribute more than ever to hazard assessments, particularly for flood and fire monitoring by increasing vastly the temporal resolution (10 minutes to 30 seconds) by the deployment of a new generation of geostationary imagers. NOAA is providing the first ever integration of geostationary and polar orbiting satellite observations for flood monitoring.

VI. Earth Observation Gaps in Disaster Risk Management

As WGDisasters strives to enhance the scientific and technical work on DRR / DRM and its mobilization through the coordination of existing networks and scientific research institutions at all levels and in all regions, it identifies research and technology gaps. Gaps caused by single points of failure in infrastructure, data exchange mechanisms, and sharing policy, as well as technical and administrative

roles are a major threat to sustainable DRM; compounded by lack of complimentary data both of in situ and socio-economic; and insufficient or nonexistent capacity development.

- Political Gaps

WG Disasters strategy to promote space data for DRM through pilots, demonstrations, observatories and platform development have revealed that lowering policy barriers would strengthen, as appropriate, international voluntary mechanisms for monitoring and assessment of disaster risks, including opening sources of relevant data and information. CEOS has the technical tools to show how EO data and relevant products can satisfy competing interests for DRM.

National policies constraining data exchange mechanisms and restricting data sharing, either in resolution or near real-time, slowing down or making overly complex processes and agreements, and adding steps that are too costly and labor-intensive, remain impediments to sustainable DRM observation and services. With commitment at the leadership level, technical programs, projects and activities can better align with the Sendai Framework targets and reporting indicators, comply with the data principles of GEO, and still serve the practical economic and security interests of national stakeholders.

WGDisasters *finds that CEOS needs to develop a simple, common approach to data ordering across agencies.*

Finally, WGDisasters finds that to open data access, use and utility may involve CEOS members working more closely and routinely with DRM stakeholders having responsibility and authority to influence standards and procedures.

- Regional Ground-Based Infrastructure Gaps

Regional gaps, especially for remote at-risk areas and coastal communities, developing countries and in the global south, exist for all in-situ or satellite observation systems. Many areas lack sufficient coverage or reference stations complementary to the remote sensing capabilities such as in situ observing and sensor networks for weather, water, and geohazards. There also is a gap in ground-based sensors to monitor the impacts on exposed and vulnerable populations, lifeline functions and critical assets. Similarly, there are shortages in sustained and cost-effective satellite-based dissemination systems and related information and communication infrastructures.

WGDisasters finds that a concerted effort warrants CEOS taking specific actions toward a more comprehensive and integrated observing data and communications system incorporating specific ground-based networks.

Gap example: Global Navigation Satellite Systems (GNSS) measurements of ground displacements and ionospheric delays modulated by acoustic waves coupled to the onset and propagation of a tsunami:

Major gaps in infrastructure exist in Antarctica, South and Central America, Africa, Russia, China, and on island states in the Atlantic, Indian, and Pacific Oceans. The application of advanced GNSS real time processing for positioning and ionospheric imaging provides very significant supplements and/or improvements to Tsunami Disaster Early Warning systems. Real-time and near-real-time GNSS networks observations can provide the magnitude and finite fault motions within two minutes of onset and GNSS can image the ionospheric response to ocean displacement from the tsunami development to basin wide propagation. Technology can provide cost effective, accurate, and sustainable early warning to those coastal communities in both the near and far field.

WGDisasters finds that CEOS and partners should identify and leverage non-traditional observation applications and novel combinations of existing and planned satellite missions in next-generation observation strategies for DRM.

- Capacity Development Gaps

Aside from geographical infrastructure gaps, major gaps in both operations and services exist in the human factors sector.

Often there are "single points of failure" embodied in one person, losses in institutional memory and continuity that provide a critical set of skills or services to the broader data acquisition, analysis, product generation, and data product delivery. The opportunity to increase and serve the needs of early adopters and new users of EO data also requires a dedicated commitment to capacity development.

WGDisasters finds that in practice, the return on investment for developing and transitioning capacity where needed serves the interest of CEOS and promotes open data access, use and utility for DRM. Application development and co-development with user communities, and related capacity building opportunities should be integral to workplans.

- Administrative and Information Technology Support Gaps

There is also a need for sharing of administrative/support/IT resources, as this has a great amount of commonality and redundancy across observations and services, and is too often dependent on an individual-entity, best-effort level.

WGDisasters finds that socializing of common website design and maintenance would be of tremendous financial efficiency to the overall data acquisition, coordination, analysis, and distribution effort for DRM.

WGDisasters finds that reliable and consistent access to broadband communication technologies, as well as access to key utilities such as uninterrupted power supplies, constitutes a serious gap in DRM.

- Strategic Implementation of DRM Observations and Services Gap Analyses

An effective strategy to open space data advancing EO for DRM and to achieve DRR outcomes for sustained resilience will include the following measures to identify the aforementioned gaps in a given situation:

  - Identify existing data sources, source organizations and need for science and technology or policy agreements or other mechanisms to ensure DRM projects have free and open access to, and stewardship accountability for, data as needed;
  - Identify optimal network configuration and data requirements including number of in-situ/ground-based infrastructure, data processing and analysis centers, data stewardship and management methodologies;
  - Identify relevant models, visualization approaches and related requirements;
  - Set the stage for future discussions of impacts of data on hardware and software requirements (e.g.: ground-based infrastructure, computers, analysis software, cloud storage systems);
  - Identify cooperative activities to validate the development of EO-based DRM resources, especially those developed by the UNDRR, including:
  - Sendai Framework for DRR,

- Global Risk Assessment Framework (GRAF),
- Global Assessment Report on DRR (GAR),
- UN GGIM-World Bank Integrated Geospatial Information Framework (IGIF)
- UN GGIM WG-Disasters Strategic Framework on Geospatial Information and Services for Disasters
- Sustainable Development Goals (SDGs);
- Identify sensitivities and political barriers to data sharing, and suggest improvements or alternatives;
- Encourage stakeholder and country participation in geodetic capacity building, and provide a mechanism to develop and disseminate relevant technical material/resources.

VII. Conclusion

CEOS can make a meaningful contribution to international activities, tying satellite Earth Observation to disaster risk management, given the impressive opportunities the increased use of satellite EO holds for decision makers and actions that protect the lives and livelihoods of at-risk communities.

Active engagement by the CEOS community with stakeholders and partners is required to advance and sustain DRM. This includes establishing and strengthening intergovernmental coordination forums composed of relevant stakeholders at the national and local levels, such aligning with Sendai and GEO. This serves to gain an understanding of their fundamental and practical requirements for EO and application prior to taking implementing steps to prevent disasters. This in turn helps ensure that CEOS objectives are met and that results achieved by stakeholders are sustainable.

CEOS agencies have much to offer and gain by strategies focused on important disaster variables, the available open data of different spatial and temporal resolutions, development of simple, common approaches to data ordering across agencies and applicable latencies of date critical for disaster management and data-driven decisions. The way forward for CEOS must address the expansion of efforts relevant across the full disaster management cycle and the closing of policy, infrastructure and capacity shortfalls and exploiting frontier technology. This means improving routine observation and monitoring in areas and communities at risk to smarter autonomous sensor webs, using the most effective information and communication technologies, computing and intelligent systems, and active targeting serving DRM. Progress should continue on the expansion of resilience projects and recovery observatories and the innovation of platforms for easier processing and analysis.

The role of CEOS in disasters is not constrained to just the mobilization around disaster events but recognizing that EO spans the full cycle of disaster management — risk mitigation, preparedness, warning, response, and recovery, and complements a wealth of other physical, social and economic data and information. The role of the WGDisasters is to assist CEOS by identifying strategic priorities such as the data access, use and utility issues presented in this document, pilot and demonstrate solutions and assist to close gaps. Similarly, while satellite offer an exceptional means to document hazards and their impacts, a solid risk mitigation strategy requires agencies to consider how satellites inform the full risk equation, including hazard, exposure, and vulnerability, highly related to socio-economic issues. Significant challenges remain in the international community specifically with regard to rapid mapping of

exposure and to integration of socio-economic data and models, and satellite have a role to play in addressing these challenges.

Specific attention is growing on the role and value of open and free data, and research, operation and business practices are evolving along with rapid growth in data and implementing technologies. CEOS agencies offer a unique perspective through the contribution of both open and commercial data sets, and the pilot and demonstrator approach developed within the CEOS WG Disasters offers a promising test bed to promote the use of all available resources, and showcase the complementarity of open and commercial data sets. It also offers a context in which to develop new services that facilitate the uptake of data and derived products by communities less familiar with their value to DRM. To this end, CEOS can advance EO for the resilience of communities and the EO enterprise.

Annex 1: CEOS WGDisasters Terms of Reference (2019)

Issue 4, 22 July 2019

Mission Statement

The Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGDisasters) ensures the sustained coordination of disaster-related activities undertaken by the CEOS Agencies and acts as an interface between CEOS and the community of stakeholders and users involved in risk management and disaster reduction.

Membership

Membership is open to all CEOS Agencies (Members and Associates). In addition, the Working Group includes experts from non-CEOS Agencies who have relevant expertise to contribute to the objectives of the WGDisasters. These experts may be selected to co-chair activities within the WG.

Objectives

The main objectives of the CEOS WGDisasters are:

- To support the efforts of Disaster Risk Management authorities in protecting lives and safeguarding property by means of satellite-based EO and science-based analyses;
- To foster increased use of EO in support of Disaster Risk Management;
- To support the Implementation of the Sendai Framework for Disaster Risk Reduction, and in particular contribute to its Priority 1 “Understanding Risk”; and
- To raise the awareness of politicians, decision-makers, and major stakeholders of the benefits of using satellite EO in all phases of Disaster Risk Management.

In pursuit of these objectives, the WGDisasters should:

- Contribute to the monitoring of the implementation of this Framework;
- Support the work of international initiatives such as for instance the Group on Earth Observations, in so far as it is related to risk and disasters, in particular by contributing to or leading Initiatives, Community activities or other GEO-related activities;
- Strive to increase the awareness of decision-makers of the critical role of satellite EO; and
- Reinforce the need for enhanced satellite EO programs to better address DRM needs.

To achieve these objectives, the WG Disasters shall draft and regularly update a Disaster Risk Management Earth Observation Strategy. This Strategy should:

- Identify and assess gaps in Earth Observation data necessary to address all parts of the disaster management cycle with the aim of better supporting the needs of the user community involved in disaster risk management.
- Be focused on risk rather than hazards alone, through activities that support hazard, exposure, and vulnerability assessment;
- Be global in scope, but building on strong partnerships at local/national or regional levels;
- Be realistic, in that it begins with achievable outputs and grows iteratively to global impact through partnership;

- Be user-driven (i.e. defined from user information needs and based on the engagement of the diverse user communities involved in DRM);
- Take into account the needs of the science community in respect of how to better understand natural hazards and related disaster risks with the help of satellite-based EO;
- Address the full-cycle (i.e. address mitigation/preparedness, warning, response/recovery, etc.);
- Address multiple hazard types;
- Take into account all relevant EO based capabilities available (such as for instance the International Charter Space & Major Disasters, Copernicus Emergency Management Service, Sentinel Asia, etc.) or under development; and
- Be sustainable in the long-term through partnerships with non-space organizations, in particular with international DRM stakeholders from the international donor community.

In the delivery of its mandate, the CEOS Working Group on Disasters will:

- Identify priority areas and initiatives within the theme of risk management and disaster reduction that should be supported by the CEOS Agencies;
- Represent CEOS in the GEO Work Plan activities (to include leadership of Tasks and Components, as determined by CEOS leadership) and develop CEOS Actions to support the execution of the GEO Disaster Tasks and Components in accordance with CEOS Work Plan;
- Ensure the coherency and the proper coordination of CEOS Agencies resources that support disaster-related activities undertaken by CEOS;
- Interface the major stakeholders and other representatives of user communities including both scientific and other users involved in disaster risk management, to better understand and assess their needs and priorities, taking into account the resources available in the CEOS agencies;
- Advise and coordinate CEOS Agencies in better use of existing assets and the deployment of new assets that will reduce address needs and priorities;
- Maintain a close dialogue with GEO and UNDRR experts to ensure appropriate recognition for the use of space-based Earth Observations within the Sendai Framework. Relevant activities will include and leverage existing disaster-related efforts supported by CEOS Agencies;
- Identify and establish a dialog with the major potential funding agencies active in this domain;
- Undertake any other relevant activities as instructed by CEOS Chair.

The Group shall operate under the same procedures of conduct as established CEOS Working Groups.

Structure and Procedures

A WGDisasters Chair and Vice-chair will be designated by the CEOS Plenary and will rotate among WG members every two years. Both will be staff from CEOS Agencies. In addition, WGDisasters Chair will provide administrative support during the whole chairmanship period. The designated Vice-chair will assume the chair after two years, and a replacement Vice-chair will be designated by Plenary.

Each CEOS Agency is invited to designate a point-of-contact for WGDisasters correspondence and representation; otherwise correspondence will be addressed to the Agency's main point-of-contact within CEOS.

The WGDisasters will normally meet twice per year, rotating the meeting venue among its membership or locations conducive to WGDisasters goals. Remote participation at these meetings will be possible. At each meeting, the time, place and host for the next meeting will be established.

For each meeting, the Chair of WGDisasters will prepare the agenda prior to the meeting and distribute notes and actions following the meeting. WGDisasters Chair will be responsible for following actions established during their chairmanship.

The CEOS WG Disasters has a sub group, the Data Coordination team, which is responsible for coordinating the CEOS WG Disasters response to all data requests for disaster related activities. It formed by representatives from all CEOS agencies contributing data through the WG Disasters, and is responsible for its working procedures.

The WGDisasters will coordinate its work with other CEOS Working Groups, the Virtual Constellations, and with the CEOS SIT who will be invited to send a representative to WGDisasters meetings to facilitate coordination.

The WGDisasters may propose modifications to these Terms of Reference, and such modifications will be submitted to CEOS Plenary for approval.