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Statement of Work
ESA Express Procurement “EXPRO”

**Disaster Risk Reduction using innovative data exploitation
methods and space assets**

Reference **EREN-DTEX-EOPS-SW-14-0002**
Issue **1**
Date of Issue **7.10.2014**
Status **Final**
Document Type **SOW**



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1 INTRODUCTION

1.1 Scope of the Document

This document describes the activity to be executed and the deliverables required by the European Space Agency in relation to *Disaster Risk Reduction using innovative data exploitation methods and space assets*. It will become part of the Contract and shall serve as an applicable document throughout the execution of the work.

1.2 The General Studies Programme

ESA's General Studies Programme (GSP) (www.esa.int/gsp) interfaces in different ways with all of ESA's programmes, but its main role is to carry out preparatory analysis and act as a "think tank", laying the groundwork for the Agency's future activities.

The objectives of the general studies programme are to:

- Contribute to the formulation of the overall ESA strategy
- Study feasibility for selection of new mission concepts
- Prepare/demonstrate the case for approval and funding of new optional projects/programmes
- Support the evolution of ESA by analysing and testing new working methodologies

A diversity of topics is investigated via GSP undertakings, running across the entire spectrum of the Agency's activities. In average, each study lasts one to two years, sufficient time for in-depth exploration of each subject.

The assessment studies undertaken by the GSP provide ESA and its member states with the necessary information on which to base their decisions about the implementation of new programmes and the future direction of space activities.

1.3 Background for the activity

The domain of Disaster Risk Management (DRM) covers both disaster response and Disaster Risk Reduction (DRR, typically risk assessment, prevention, etc.). The framework of the activities developed by users and practitioners of the DRM sector are defined in the Hyogo Framework of Action (HFA).



According to Agence France Press (AFP) as quoted at www.undp.org, in 2010, disaster events caused the death of almost 300,000 people, affected another 220 million and resulted in more than \$120 billion in economic damages. Impacts of disaster events on economic and human lives are increasing every year due to growing urbanization and an increase in the number and severity of weather-extreme events; While 2011 saw a drop in fatalities (29,782), the damages tripled to over \$366 billion. The Japanese earthquake and tsunami of March 2011 accounted for over half these damages on its own. According to AFP some 206 million people were affected by disasters in 2011, including 106 million by flooding and 60 million by drought, mainly in the Horn of Africa. Today, apart from the immediate disaster response phase, space technologies are rarely used operationally to address Disaster Risk Management (DRM) needs. Concerning space technologies, users are not aware or do not view space assets as mature, in particular EO, and seek clearer demonstrations of the cost-benefit ratio that would convince their own management and stakeholders that EO represents a solution to risk management challenges. In addition there are blockages associated with exploiting space technologies, in particular newly available and planned Satellite EO missions provide massive data volumes and the scale and complexity of the services based on these data are becoming more and more problematic.

As far as the international collaboration between space agencies is concerned, in 2012 CEOS created the ESA-led Disasters ad hoc Team composed of ASI, CNES, CSA, DLR, ESA, JAXA, NASA, NOAA, and USGS, which produced a Consensus Report on Enlarged Contributions to DRM for CEOS. This team is now integrated into the new CEOS Working Group on Disasters (WGDisasters). This report was the direct impetus for the recently approved CEOS DRM Observation Strategy, a clear plan to observe global disaster hotspots in support of risk reduction for floods, volcanoes and seismic hazards. The three thematic pilots and Recovery Observatory put forward in this Strategy are detailed below. Beyond the three pilots, the long term strategic vision of CEOS space agencies is to foster progressively but significantly the use of EO satellite data for all types of disasters, at global, regional and local level thanks to a better coordination of the resources available. However the CEOS WGDisasters is limited to satellite EO and cannot address other components that are important to the realization of a capacity really meeting user needs; the components that the CEOS activity cannot address comprise in situ information, other space technologies and IT. Furthermore the CEOS activity is primarily a best effort activity without direct support from existing programmes.

Concerning Disaster Risk Reduction i.e. other phases of DRM than disaster response, such as prevention and preparedness, the level of use of space assets is embryonic. Apart from a few precursor projects these users generally do not access space technologies outside the immediate emergency response phase. This is even more the case outside Europe and in developing countries.



Looking at geohazard science, GEO's Geohazard Supersites and Natural Laboratories (GSNL) began with the "Frascati declaration" at the conclusion of the 3rd International Geohazards workshop held in November 2007 in Frascati, Italy. The recommendation of the workshop was "to stimulate an international and intergovernmental effort to monitor and study selected reference sites by establishing open access to relevant datasets according to GEO principles to foster the collaboration between all various partners and end-users". The supersites are supported by numerous partners including GEO, ESA, JAXA, NASA, DLR, ASI, NSF, UNAVCO and the European Plate Observing System (EPOS). They are not intended to be global in their reach, but to provide data for type examples of hazardous systems or natural laboratories (supersites.earthobservations.org/).

New information technologies such as exploitation platforms, cloud computing, e-science, etc. have started to be considered in DRR; this is the case for instance with: wide extent geohazard inventories (e.g. landslide inventory mapping, tectonic hazard mapping, flood hazard mapping, etc.). Indeed with the advent of big data exploitation scenarios, the concept of "Thematic Exploitation Platforms" (TEP) is increasingly presented as one of the potential solutions to enable access to and exploitation of large volumes of data, a new aspect of satellite missions linked to the evolution of sensors and ground segments that is a characteristic of new and planned EO missions. The trend is that missions will deliver Petabytes per year, and users will require high-speed network connections (e.g. GEANT) – including two elusive elements for the user; huge data storage; and massive processing power. Until now data was distributed to which ever users required them, either by ordering or simple on-line access, and the exploitation work (and further processing) would take place at the user's premises, typically on the users' proprietary infrastructure. The concept of TEP is based on facilitating data access and exploitation by moving the user's 'desktop' (and associated software) to the data, rather than moving the data to the scientists, thereby enabling ultra-fast data access and processing, and finally transferring a few Megabytes of results rather than several Tera/Petabytes of raw data to the user. For instance e-infrastructures using cloud computing are being considered to support international projects using large data volumes from EO missions with the geohazard supersites (GSNL). In this logic and in the context of the CEOS WGDisasters and its Thematic Pilots, ESA has initiated the development of the Super Site Exploitation Platform (SSEP). ESA is supporting the development of a range of TEPs in the framework of R&D activities on ground segments. The development of SSEP has already been started and the associated user community is approached via the CEOS Pilot on seismic hazards and the CEOS Pilot focused on volcano monitoring. In the context of new ICT for satellite EO, ESA is also at the origin of the 'Helix Nebula: the Science Cloud' initiative (www.helix-nebula.eu) which aims to pave the way for the development and exploitation of a Cloud Computing Infrastructure for European IT-intense scientific research organisations and other stakeholders such as governments, businesses and citizens.



As far as users and stakeholders of DRM are concerned, decisions generally are taken at the local level, or through the impetus of a national initiative or legislation. DRM end-users are thus not regional or international, which poses challenges for coordinated global actions. DRM involves diverse and numerous actors that have different institutional mandates in the various phases of DRM, such as nationally mandated organisations and state governments. DRM users also comprise organisations with other mandates than Civil Protection. They include operational and scientific users with a focus on different aspects of risk assessment and / or hazard response. For instance, for Earthquake risks, users include seismological centers, national and local authorities in charge of seismic risk management activities (who are concerned with the different crisis phases: prevention, preparedness, early warning, response, recovery, rehabilitation and reconstruction. Beyond operational users with a mandate in seismic risk management, there is a range of geoscience users focused on the scientific use of data with the main goal of understanding the physics which drives earthquakes, with the aim of improving our ability to characterize, understand, and model seismic risk. In addition users potentially include specialists of geohazard risks in other sectors e.g. insurance/re-insurance sector, civil engineering companies, energy, etc.

Users at the international level, are in fact stakeholders, introducing policy initiatives but not directly responsible for disaster risk reduction or disaster management per se. These actors include stakeholders in the international humanitarian community (with a focus on Disaster Response) and in the international development community (with a focus on Disaster Risk Reduction). Examples include the United Nations and other international organisations, all have mandates related to disaster risk reduction (e.g. UNISDR, UNDP, UNEP, UNITAR/UNOSAT, etc.); donors Governments (including governmental agencies) and international/regional development banks such as International Financial Institutions (e.g. GFDRR, World Bank, Inter-American Development Bank (IADB), Asian Development Bank (ADB), etc.) or umbrella organisations (e.g. GEO); non-governmental organisations (NGOs), both national and international, including associations of NGOs (e.g. International Federation of Red Cross and Red Crescent Societies IFRC, VOICE, CARE, etc.); private sector companies. There are global industry players with an interest in improved knowledge and tools concerning hazards and risks, such as for example insurance & re-insurance companies. For instance, today, the insurance sector invests in R&D to improve knowledge on hazards and exposure and is starting to consider how Earth Observation can help better assess risks for flooding (supported full scale trials for flood impact estimation) and earthquakes (contribution to the Global Earthquake Model 'GEM' initiative to provide hazard mapping and modelling and exposure data). In the longer term these are the potential new users for space based applications.

Different types of user organisations of the DRM sector have been engaged in applications of space technologies; this is particularly true concerning the response to emergencies. However there are many types of organisations who are not using space assets in other phases of the risk



management cycle in particular in disaster risk reduction (e.g. prevention and preparedness) although there are clear and concrete needs for geo-information concerning DRR. Such requirements have been elaborated in the different thematic user communities, for instance through the International Forum on Satellite Earth Observation for Geohazard Risk Management concerning users and practitioners of the geohazard domains from 20 countries (see <http://www.int-eo-geo-hazard-forum-esa.org/>). Similarly concerning flood hazards, the Flood Thematic Pilot set up in the framework of the CEOS WGDisasters, or the Global Flood Partnership led by the EC/JRC are addressing how satellite EO can contribute to flood hazard mapping globally. The CEOS WGDisasters has started to investigate other DRM themes such as e.g. seismic hazards and volcanoes.

There are many constraints for using satellite EO in crisis management (disaster response phase) and they relate to a broad range of factors some relating to the ability of the EO mission to access and monitor the target area at the right time, some relating to the ability to extract the needed information about the hazard impact. For other phases of DRM that do not have timeliness constraints, such as typically risk assessment for prevention, the level of use of satellite EO is still limited and there are several reasons for this, primarily the lack of awareness of the benefit that space technologies can provide, and, secondly challenges associated to current space based techniques; for instance providing hazard mapping information globally requires to access and process very large collections of satellite data. There are barriers to the exploitation of space assets in DRR primarily because of the variety, complexity and cost associated with it; recent advances in IT demonstrate that some of these barriers can be overcome by changing the way innovation is accessed outside the space domain. The mutualization of resources including big data for science, multiple user models for service delivery, new paradigms to disseminate products and service such as Earth Observation based products and including commercial products, are examples of what new ICT approaches can provide.



1.4 Reference Documents (RDs)

During the development of this contract, additional activities developed in the framework of CEOS, GEO and the Helix Nebula initiative could generate useful complementary information:

- http://www.ceos.org/index.php?option=com_content&view=category&layout=blog&id=351&Itemid=492
- http://www.earthobservations.org/geoss_ditar.shtml#
- www.helix-nebula.eu

The following documents can be consulted by the Contractor as they contain relevant background information:

URL-GH01	Scientific & Technical Memorandum of the International Forum on Satellite EO and Geohazards, doi:10.5270/esa-geo-hzrd-2012	http://esamultimedia.esa.int/docs/EarthObservation/Geohazards/esa-geo-hzrd-2012.pdf
URL-GH02	The CEOS Disaster Risk Management Pilot Proposals and Annexes	http://www.ceos.org/index.php?option=com_content&view=category&layout=blog&id=355&Itemid=491
URL-GH03	The Supersites Exploitation Platform	http://gpod.eo.esa.int/services/?q=ssep&count=8&rating=&class=&category=
URL-GH04	The Supersites Exploitation Platform wiki	https://wiki.services.eoportal.org/tiki-index.php?page=SSEP .
URL-GH05	The Geohazard Supersites and Natural Laboratories	http://supersites.earthobservations.org/
URL-GH06	The European Plates Observing System	http://www.epos-eu.org/
URL-GH07	CEOS Handbook on DRM	http://www.eohandbook.com/eohb2014/case_studies_satellite_earth_observation_for_disaster_risk.html
URL-GH08	Space Frequency Coordination Group	https://www.sfcgonline.org which focuses on disasters
URL-GH08	Final Report of the Geo-Oculus study	http://emits.sso.esa.int/emits-doc/ESTEC/AO6598-RD2-Geo-Oculus-FinalReport.pdf



1.5 Acronyms and abbreviations

CEOS: Committee on Earth Observing Satellites
DRM: Disaster Risk Management
DRR: Disaster Risk Reduction
EO: Earth Observation
ESA: European Space Agency
GEO: Group on Earth Observations
GEOSS: Global Earth Observing System of Systems
GFDRR: Global Facility for Disaster Reduction and Recovery
GNSS: Global Navigation Satellite System
GSNL: GeoHazard SuperSites and Natural Laboratories
HFA: Hyogo Framework for Action
InSAR: Interferometric SAR
ICT: Information and Communication Technologies
KO: Kick off meeting
MDG: Millennium Development Goals
SAR: Synthetic Aperture Radar
SOW: Statement of work
TEP: Thematic Exploitation Platform
WCDRR : World Conference on Disaster Risk Reduction
WP: Work package



2 OBJECTIVES AND SCOPE OF THE ACTIVITY

The purpose of this activity is to study the expansion of the use of space technologies and the contribution of existing federated cloud infrastructure i.e. Helix Nebula, the Science Cloud in the domain of Disaster Risk Management (DRM) with specific focus on Disaster Risk Reduction (DRR) – in particular hazard mitigation/prevention/preparedness (rather than disaster response).

The aim of this study is to investigate the contribution of current space assets and to determine, for a set of activities within the very broad DRM theme, what future space assets could be designed by ESA and by the international space community to better meet user needs.

As a baseline planning of this activity a balance is sought across several, at least two, themes (i.e. hazard types). Priority theme areas have been identified: floods, seismic hazards, landslides, subsidence and volcanoes.

Several initiatives concerning satellite EO and DRM have already been conducted, such as for instance in the framework of CEOS and GEO as described in section 1.3. It is noted that users and practitioners have already taken part to various meetings, reviews and workshop which has led to a certain user fatigue. To avoid such a user fatigue it is intended that this activity will take full account of the available documentation concerning the objectives of the user communities (e.g. as in URL-GH01 to URL-GH07).

The proposed activity has a global scope i.e. addresses the development of space applications world-wide with emphasis on countries that do not currently have wide access to space technologies and that would have greater benefit in integrating them in their scenarios of operations and on international and regional initiatives concerning DRR.

Looking at the needs of local, national and regional/global organisations, and taking account of what is available now and what needs to be improved, the challenges to be addressed include:

- can local hazard maps be generated using satellite EO? What is available, what needs to be improved?
- Can these maps be generated over extended areas and is it possible to provide global hazard maps for different hazard types ?

This activity has the aim to:

- 1) Study, and test through trial cases, how to better exploit and accelerate the utilization of space assets and innovative data exploitation methods in the domain of Disaster Risk Management with specific on Disaster Risk Reduction. To achieve this will require to consider the contribution of innovative data exploitation methods (e.g. cloud computing for big data) able



to address identified challenges concerning the development of space applications. The proposed activity concerns space assets in general with primary focus on satellite EO and in particular ESA missions, including mission archives and the new Sentinel missions (such as Sentinel-1, Sentinel-2 and Sentinel-3 providing systematic High Resolution data), and European national EO missions both SAR and Optical. While it is not the main study focus, other space assets will also be considered in navigation and satcom. For instance for seismic hazards, modelling the global strain rates using INSAR data from EO missions and GPS data can help better understand and assess earthquake hazards.

- 2) investigate new space assets that would be more directly addressing user defined criteria concerning the availability, accuracy, fitness for purpose and affordability of the information services for different phases of Disaster Risk Management. In particular new types of EO missions and sensors could be considered with focus on already identified concepts such as: high frequency SARs, low frequency SARs, high resolution thermal imaging sensors, sensors in different orbits such as LEO, GEO, highly inclined orbits etc; identification of potential measurement synergies, different type of measurement techniques such as InSAR and new measurement possibilities leading to convoy and constellations. Already, national and international user organisations of the risk management sector were represented at ESA's GEO-HR workshop in Rome on 25 April 2013 to discuss requirements concerning an Optical mission in geostationary orbit in the framework of GEO-Oculus (see URL-GH08). In the present activity the intention is to consider all types of EO missions (including GEO and LEO missions) and focus on user needs for the broad DRR domain and per scenario of use, solutions available today and identification of gaps and a preliminary discussion of new EO mission concepts. Investigating new space assets for disaster risk management will take full account of the state of the art concerning future missions.

It is not the intention of this activity to provide a full proposal for any EO mission. The aim (particularly aimed at task 5) is for the activity to explore the feasibility of possible in-orbit capabilities (both in terms of observations and measurement techniques) to support disaster risk reduction (DRR).



3 WORK TO BE PERFORMED

3.1 Work Logic

The work is organised as follows:

- An analysis phase (Tasks 1 & 2) where users take part in a review of the study priorities and of the analysis: duration 6 months with a consultation event (Task 3) at KO+4 months including a readiness review of the trial cases.
- Trial cases (Task 3) to illustrate methods with users: duration 1 year, KO+6 months to KO+18 months.
- An analysis looking at future space assets for DRM (Task 5): starting at KO+4months with iterations: KO + 12 months to KO + 18 months.

3.2 Tasks

3.2.1 *Task 1: gathering & assessing geo-information needs concerning DRM.*

- Task description

The Contractor shall:

- characterise user organisations for a selection of at least 10 representative user organisations in at least three different geographic regions in different parts the world; this shall be conducted , according to their mandate, and the different scenarios concerning how they operate (e.g. risk assessment to support prevention, preparedness, etc.).
- Identify user needs according to the scenarios and assess existing mechanisms already in place for supporting them using geospatial information. Analyse and prioritize user needs including local/national users, users/stakeholders of the international development community and science users. The prioritization shall be based upon the relevance of geo-information needs and the ability of satellite EO to have a strong impact. The assessment shall identify priority need areas for focus using a range of scenarios concerning how users operate .
- As a foundation for the study provide an inventory of the geospatial tools, data storage and processing services and platform that are available to user organisations. Provide a discussion of the gaps between these assets and what is needed.

- Output / Approval conditions

Needs Baseline Report, a report of the assessment of user needs according to DRR themes and scenarios.



3.2.2 Task 2: Analysis of the contribution of space technologies and new ICT in DRR

- Task description

The Contractor shall:

- Characterize of the role of space technologies and new ICT, including the contribution of Helix Nebula.
- Analyse the contribution of space technologies to hazard mapping & risk assessment via in depth analysis of a selection of priority need areas for at least two hazard types (within hydro-meteorological hazards, earthquakes, volcanoes, landslides, etc.).
- For these hazard types list the major available data sources (space & airborne and terrestrial) and the synergistic (EO and non EO) exploitation techniques identified by users (under the assumption that necessary data are available).
- For these hazard types analyse the cloud readiness of existing infrastructures/tools and provide a roadmap to reach federation.

Output / Approval conditions:

- Report of the Assessment of the contribution of new space & ICT solutions to support DRR, including the prospectus of satellite EO data and satellite EO based processing techniques relevant to the hazard types subject of the investigation.
- Roadmap for virtualization and federation of existing IT dedicated resources

3.2.3 Task 3: Support user consultations and define trial cases

- Task description

The Contractor shall:

- Support ESA for the organization a meeting to consult with users, discuss and agree a plan to test technology with trial cases to demonstrate the value of space assets to DRM, in particular by presenting them in a non-satellite centric, 'integrated' solution that shows how space technologies can be enablers, bringing innovative solutions to traditional DRM challenges.
- Present the analysis in T1 and T2 and discuss templates describing the tests to be run with users
- Gather review comments from users concerning the trial cases plan



As part of the trial cases plan, for each of them, specific parameters shall be recorded including the following:

- number of users (and increase over time),
 - statistics on data usage,
 - computing hours,
 - tool usage;
 - identification of users.
-
- Output / Approval conditions
 - Consultation planning document.
 - Report of consultation meeting including information material package.
 - Readiness review report concerning the trial cases (to be run under Task 4). The report shall include the definition of the trial cases including templates describing the tests to be run with users which will be filled in during the trial cases and the collection of comments from users concerning requirements to be met in the trial case.

3.2.4 Task 4: Trial cases and test data

- Task description

At least two trial cases will be run in parallel which address two different hazard types.

The Contractor shall:

Run trial cases with providers and users of space technologies; the trial cases will exploit EO data using processing, modelling, etc. They shall include inclusion of Sentinel-1 and data from available national EO missions from Europe.

The trial cases shall provide examples including data and prototype products. They shall combine satellite EO and other data sources (e.g. in situ/terrestrial) and processing techniques to exploit them and should illustrate the ability to perform data exploitation on large data collections. Each trial case shall use representative data collections (concerning the space and time of observations) with processing to extract information from satellite EO data.

- Output / Approval conditions
 - Report of the trial cases detailing the entire exercise including results and conclusions. Package of trial cases report, including records of users and usage.
 - User utility reports.



3.2.5 Task 5: Requirements baseline for future space assets for DRR

- Task description

The Contractor shall perform the following:

User Needs Analysis

- Characterise and describe the trial cases identified in Task 4. Identify appropriate phases e.g. prevention, preparedness, early warning, etc.
- Perform a user needs analysis for all phases of the DRM including DRR. Identify and describe user needs for each of the hazard types trial cases identified in Task 4.
 - Minimum elements to be considered include:
 - What information and observations are typically required e.g. land and river maps, soil and rock types, hydrology information, urban mapping, resource mapping.
 - What detailed observations and information are typically required e.g. change detection information, large context mapping, detailed local mapping
 - What type of space borne information is typically used e.g. optical, SAR, hyperspectral etc. If space-borne information is not typically used then characterize the data that typically is used for this hazard type.
 - What spatial resolution is typically needed e.g. minimum discernible object such as a house, car, tent, person.
 - What temporal resolution is typically needed e.g. how quickly information needs to be refreshed.
 - What availability is typically needed?
 - What accuracy is typically needed?
 - What measurement techniques are available and which could support DRR e.g. single pass and repeat pass interferometry. Are any of these techniques utilized in DRR at present if so describe.
 - Are fused data products used to support DRR? If so which fused data products are used. If not then identify which fused data products could effectively support DRR e.g. optical and thermal infrared, SAR and optical
 - What support information is typically needed e.g. meteorological etc

Baseline Requirement Analysis

- Derive specific requirements for the identified trial cases based on the above user needs analysis (requirements can be an individual value or range based). Focus must be on DRR.
- Define a baseline set of requirements with options for each identified trial case hazard type (focusing on DRR).
- If measurement techniques are required e.g. InSAR identify requirements, which are needed to achieve these techniques.

In-orbit capability assessment and gap analysis

- Perform an assessment focused on the capability of current and firmly planned EO missions (both European and International) to meet these requirements (specifically focus on DRR).



- Identify criteria to judge capability such as e.g. availability and fitness for purpose etc.
- Provide a matrix or similar to illustrate present and firmly planned in-orbit capability
- Perform a gap analysis comparing the baseline requirements (and options) with the results of the in-orbit capability assessment. Identify any gaps in in-orbit capability. Characterize and describe this capability gap.

New Mission Identification and Feasibility Analysis

- Based on the baseline requirements and the gap analysis identify, investigate, propose and assess new types of dedicated missions that would more directly address the user needs for each trial case hazard type e.g. Earthquake, landslide, flood etc.
- The main characteristics of the EO mission shall be based upon user driven parameters such as spatial scale of observation, type of thematic feature to be observed, timeliness of the geo-information provision, etc.
- It is advised to assume that Sentinels 1, 2 and 3 are already in-orbit (each with two satellites).
- Investigate new space assets that would be more directly addressing user defined criteria concerning parameters such as availability, accuracy, fitness for purpose and affordability of the information services for different phases of Disaster Risk Management. In particular new types of EO missions and sensors could be considered with focus on already identified concepts such as: high frequency SARs, low frequency SARs, high resolution thermal imaging sensors, sensors in different orbits such as LEO, GEO, highly inclined orbits etc.; identification of potential measurement synergies, different type of measurement techniques such as InSAR and measurement possibilities leading to convoy and constellations. An non exhaustive list indicating elements to consider can be seen below:
 - New stand alone and / or missions flying in constellation with other satellites
 - New orbits e.g. LEO, GEO, high inclination orbits
 - New missions using measurement techniques such as e.g. single pass and repeat pass interferometry, etc.
 - New resolutions (spatial, temporal)
 - New multispectral and hyperspectral solutions
 - New frequencies (SAR)
 - New regions of the electromagnetic spectrum
 - New data products
 - New methods
 - New constellations and formations
 - Other, etc.
- Perform Step 1: Identify and Assess New Mission Ideas
 - *Identify and describe criteria for proposing new mission ideas dedicated to DRR. Criteria examples include fitness for purpose, availability, complexity, accuracy, affordability etc.*
 - *Define possible new missions including preliminary space and ground segment analysis and considerations. The space segment analyses shall include preliminary payload and platform aspects.*
 - *If new measurement techniques are advocated assess the impact of utilising this technique on the space and ground segment.*



- *Identify and assess preliminary constellation considerations*
- *Define priorities derived from user needs analysis. Include any assumptions.*
- *Perform Step 2: Select Mission Ideas for further analysis and feasibility*
 - *Based on these priorities select at least four new missions for further analysis.*
 - *Perform a more detailed assessment of the selected new missions focusing on space and ground segment considerations. Further develop payload and platform considerations.*
 - *Further assess constellation considerations.*
 - *Identify and assess appropriate data products.*
 - *Identify and assess possibilities for fused data products*
 - *Iterate these selected missions with the results of the gap analysis and the original user needs analysis.*
- *Output / Approval conditions*

Report of the assessment of user needs and derived requirements.

Report of the EO mission capability to contribute to DRR.

Report of the in-orbit capability, user needs gap analysis and identification of new missions to support DRR.



4 REQUIREMENTS FOR MANAGEMENT, REPORTING, MEETINGS AND DELIVERABLES

The following are the requirements for Management, Reporting, Meetings and Deliverables applicable to the present activity.

4.1 Management

4.1.1 General

The Contractor shall implement effective and economical management for the project. His nominated Project Manager shall be responsible for the management and execution of the work to be performed and, in the case of a consortium, for the coordination and control of the consortium's work.

4.1.2 Communications

All communications to the Agency shall be addressed to the Agency's representatives nominated in the Contract.

4.2 Access

During the course of the contract the Agency shall be afforded free access to any plan, procedure, specification or other documentation relevant to the programme of work.

4.3 Reporting

4.3.1 Minutes of Meeting

The Contractor is responsible for the preparation and distribution of minutes of meetings held in connection with the Contract. Electronic versions shall be issued and distributed to all participants, to the Agency's Technical Officer and to the ESA Contracts Officer, not later than 10 days after the meeting concerned.

The minutes shall clearly identify all agreements made and actions accepted at the meeting.

4.3.2 Bar-chart Schedule

The Contractor shall be responsible for maintaining the bar-chart for work carried out under the Contract, as agreed at the kick-off meeting.



The Contractor shall present an up-to-date chart for review at all subsequent meetings, indicating the current status of the contract activity (WP's completed, documents delivered, etc.).

4.3.3 Progress Reports

Every month, the Contractor shall provide a Progress Report in electronic format to the Agency's representatives, covering the activities carried out under the Contract. This report shall refer to the current activities shown on the latest issued bar-chart and shall give:

- Action items completed during the reporting period;
- Description of progress: actual vs schedule, milestones and events accomplished;
- Reasons for slippages and/or problem areas, if any, and corrective actions planned and/or taken, with revised completion date per activity;
- Events anticipated during the next reporting period (e.g. milestones reached);
- Milestone payment status.

4.3.4 Problem Notification

The Contractor shall notify the Agency's representatives (Technical Officer and Contracts Officer) of any problem likely to have a major effect on the time schedule of the work or to significantly impact the scope of the work to be performed.

4.3.5 Technical Documentation

As they become available and not later than the dates in the delivery plan, the Contractor shall submit for the Agency's approval Technical Notes, Task/WP Reports, etc.

Technical documentation to be discussed at a meeting with the Agency shall be submitted electronically two weeks prior to the meeting.

Technical documents from Subcontractors shall be submitted to the Agency only after review and acceptance by the Contractor and shall be passed to the Agency via the Contractor's formal interface to the Agency.



4.4 Meetings

The kick-off meeting shall take place at the Agency's premises at ESRIN, Rome, Italy.

In addition there will be three physical meetings at ESRIN including the final presentation.

- First meeting at ESRIN at KO+2months
- Consultation at ESRIN at KO+4months; the readiness review at KO+6months will be conducted via telcon or Videocon.
- First review meeting of trial case results *at Contractor premises* at KO+12months
- Final review including second review meeting of trial case results and Task 5 results at ESRIN at KO+18months

Progress Meetings shall be held at approximately 2- to 3-monthly intervals, by video- or teleconference . This includes the Readiness review meeting at ESRIN after Task 2 where the planning and the test templates for the trial cases can be reviewed ready for the actual running of the trial cases.

Additional meetings may be requested either by the Agency or the Contractor.

With due notice to the Contractor the Agency reserves the right to invite Third Parties to meetings to facilitate information exchange.

For each meeting the Contractor shall propose an agenda in electronic form and shall compile and distribute hand-outs of any presentation given at the meeting.

4.5 Deliverable Items

In addition to the documents to be delivered according to section 4.3 (Reporting) here above, the following documentation shall also be deliverable.

All documentation deliverables mentioned hereunder (including all their constituent parts) shall also be delivered in electronic form in a format agreed by the Agency (unprotected searchable PDF format, the native format and in other exchange formats where relevant).



All the documentation shall be delivered on computer readable media (e.g. CD-ROM, DVD-ROM, e-mail) as agreed by the Agency. Unless specifically stated otherwise in the table here below, no paper copies are request.

The draft version of the documentation shall be sent to the Technical Officer in electronic format not later than two weeks before the documentation is to be presented.



Doc ID	Title	Milestone	No. of copies / Format	Remarks
DF.1	Final Report	FP	1*	These documents shall be free of all commercial/confidential information, which should be provided under separate cover if necessary. <u>No copyright nor dissemination restrictions shall be indicated.</u>
DF.2	Executive summary	FP	1*	
DF.3	Contract Closure Summary (**)	Contract Closure	1*	
D1.1	Assessment of user requirements	KO+3months: first draft; KO+6months version 1; KO+18months version 2.	1*	
D2.1	Assessment of the contribution of new space & IT solutions to support DRR	KO+4months: first draft; KO+12months version 1; KO+18months version 2	1*	
D3.1	Consultation planning document	KO+3months (1 month before user meeting)	1*	
D3.2	Report of consultation meeting	KO+5months	1*	
D3.3	Report of the readiness review of the trial cases	KO+5months		
D4.1	Report of the trial cases detailing the entire exercise including results and conclusions, including records of users and usage.	KO+12months: version 1; KO+15months version 2; KO+18months version 3		
D4.3	User utility reports	KO+12months: version 1; KO+15months version 2; KO+18months version 3		
D5.1	Report of the assessment of requirements.	KO+6months: first draft; KO+12months version 1; KO+184months version 2		



D5.2	Report of the capability of EO missions to contribute to DRR.	KO+6months: first draft; KO+12months version 1; KO+184months version 2		
D5.3	Report of the gap analysis concerning space assets to support DRR.	KO+6months: first draft; KO+12months version 1; KO+18months version 2		

(*):electronic via e-mail

Definitions of Deliverable Documents

- CONTRACT CLOSURE SUMMARY

The Contract Closure Summary is a mandatory deliverable, due at the end of the contract. For the avoidance of doubt, “end of the contract” shall mean the finalisation of a series of tasks as defined in a self-contained Statement of Work. The contents of the Contract Closure Summary shall conform to the layout provided in Annex A hereto.

- The Final Report shall provide a complete description of all the work done during the study and shall be self-standing, not requiring to be read in conjunction with reports previously issued. It shall cover the whole scope of the study, i.e. a comprehensive introduction of the context, a description of the programme of work and report on the activities performed and the main results achieved.
- The Executive Summary Report shall concisely summarise the findings of the contract. It shall be suitable for non-experts in the field and should also be appropriate for publication on the GSP website. For this reason, it shall not exceed 20 pages in total.



5 SCHEDULE AND MILESTONES

5.1 Duration

The duration of the work shall not exceed 18 months from kick-off to end of the activity (delivery of final report or hardware or software).

5.2 Milestones

The following milestones shall apply:

- KO+4 months: Consultation with users
- KO+5months: Trial cases readiness review report
- KO+6 months: Start of trial cases
- KO+12months: Interim review of trial cases and of first analysis of requirements for new space assets
- KO+18months: Interim review of trial cases and of analysis of requirements for new space assets
- KO+18months: Final review



APPENDIX A. LAYOUT FOR CONTRACT CLOSURE SUMMARY

Contract Closeout Summary
for
ESA Contract Nr. *[Contract Number]*
[Title of Activity],
hereinafter referred as the “Contract”

A1. Parties, contract duration and financial information

Contractor	
Subcontractor(s) <i>(state if not applicable)</i>	
Contract Duration <i>(insert the dates; see Article 7.1 of the Contract; also per phase, if applicable)</i>	From: To:
Total Contract Price and total contract value <i>(in case of co-funding; state if not applicable)</i>	EUR EUR



A2. Recapitulation of deliverable items

Items deliverable under the Contract

If any of the columns do not apply to the item in questions, please indicate “n/a”.

Items deliverable according to the Statement of Work

Type	Ref. No.	Name/Title	Description	Property of	Rights granted / Specific IPR conditions ¹⁾
Documentation					
Other					

¹⁾ e.g. IPR constraints, deliverable containing proprietary background information (see also 2.1.2 below)



Background information used and delivered under the Contract (see Article 6.3 of the Contract)

The following background information has been incorporated in the deliverable(s):

Proprietary Information <i>(title, description)</i>	Owner <i>(Contractor, Sub-Contractor(s), third party/ies)</i>	Affected deliverable <i>(which documents, hardware, software, etc.)</i>	Description impact on ESA's rights to the deliverable¹⁾	Other/comments

¹⁾ if not explicitly stated otherwise, the contractual stipulations shall prevail in case of conflict with the description provided in this table



A3. Output from / achievements under the Contract

3.1 Technology Readiness Level (TRL)

Indicate the TRL of the technology developed under the Contract using the classification given below:

Initial TRL	Planned TRL as activity outcome	Actual TRL at end of activity

1	Basic principles observed and reported
2	Technology concept and/ or application formulated
3	Analytical and experimental critical function and/ or characteristic proof of concept

Note: The TRL shall be assessed by ESA. The Agency’s responsible Technical Officer shall verify TRLs 1-4.

3.2 Achievements and Technology Domain

Provide a concise description (max 200 words) of the achievements of the contract and its explicit outcome (including main performances achieved): please refer to the final documentation (e.g. Final Report)

Please indicate the Technology Domain (TD 1 to 25) of the development (*please tick off*):

<input type="checkbox"/>	1	On-Board Data Systems	<input type="checkbox"/>	14	Life & Physical Sciences
<input type="checkbox"/>	2	Space System Software	<input type="checkbox"/>	15	Mechanisms & Tribology
<input type="checkbox"/>	3	Spacecraft Electrical Power	<input type="checkbox"/>	16	Optics
<input type="checkbox"/>	4	Spacecraft Environment & Effects	<input type="checkbox"/>	17	Optoelectronics
<input type="checkbox"/>	5	Space System Control	<input type="checkbox"/>	18	Aerothermodynamics
<input type="checkbox"/>	6	RF Payload and Systems	<input type="checkbox"/>	19	Propulsion
<input type="checkbox"/>	7	Electromagnetic Technologies and Techniques	<input type="checkbox"/>	20	Structures & Pyrotechnics
<input type="checkbox"/>	8	System Design & Verification	<input type="checkbox"/>	21	Thermal
<input type="checkbox"/>	9	Mission Operations and Ground Data Systems	<input type="checkbox"/>	22	Environmental Control Life Support
<input type="checkbox"/>	10	Flight Dynamics and GNSS	<input type="checkbox"/>	23	EEE Components and Quality
<input type="checkbox"/>	11	Space Debris	<input type="checkbox"/>	24	Materials and Processes
<input type="checkbox"/>	12	Ground Station System & Networking	<input type="checkbox"/>	25	Quality, Dependability and Safety
<input type="checkbox"/>	13	Automation, Telepresence & Robotics	<input type="checkbox"/>		



3.3 Application of the output / achievements

Please tick off as appropriate:

Possible use in programme:

.....

Please indicate the service domain (see table) relevant to a possible application

	1	Earth Observation
	2	Science
	3	Human Spaceflight and Exploration
	4	Space Transportation
	5	Telecommunications
	6	Navigation
	7	Generic Technologies and Techniques
	8	Security
	9	Robotic Exploration

Actual use in programme:

.....

Please describe the specific programme and application or mission for which the output of this contract is or will be used.

3.4 Further steps / expected duration

Please tick off as appropriate:

No further development envisaged.

Further development needed:

.....

Please describe further development activities needed, if any, to reach TRL 5/6 including an estimate of the expected duration.

3.5 Potential non-space applications

.....

Describe any potential non-space applications or products that may benefit from the technology that has been developed. Emphasize potential markets and costumers where known.

.....

Describe the principle features of technology that would be required in a technology demonstrator for any identified non-space application. Include an estimate of the resources in time and money that would be required.



A4. Statement of Invention

[OPTION 1: NO INVENTION]

In accordance with the provisions of the above Contract,[Company] hereby certifies both on its own behalf and that of its consortium/Sub-Contractor(s), that no Intellectual Property Right(s) has(ve) been registered in the course of or resulting from work undertaken for the purpose of this Contract.

[END OPTION 1]

[OPTION 2: INVENTION]

In accordance with the provisions of the above Contract,[Company] hereby certifies both on its own behalf and that of its consortium/Sub-Contractor(s) that the following Intellectual Property Right(s) has(ve) been registered in the course of or resulting from work undertaken for the purpose of this Contract:

.....

The Agency’s rights on such Registered Intellectual Property Rights shall be in accordance with the ESA GCC Part II provisions as amended by the above Contract.

[END OPTION 2]