

Contract No. 4000113774/15

with

CNR-IRPI

CONTRACT

Between:

ALTAMIRA INFORMATION S.L.

(hereafter called "ALTAMIRA" or "Main Contractor"),

located at:

Còrsega, 381-387
E-08037 Barcelona
Spain

represented by Mr Alain Arnaud, its Chief Executive Officer,

of the one part,

and:

Istituto di Ricerca per la Protezione idrogeologica - Consiglio Nazionale delle Ricerche (IRPI-CNR)

(hereafter called "Contractor" or "Subcontractor"),

located at:

Via della Madonna Alta 126
062128 Perugia
Italy

represented by Dr. Fausto Guzzetti, Director of the CNR Research Institute for Geo-Hydrological Protection (IRPI),

of the other part,

the following has been agreed:

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ARTICLE 1 – SUBJECT OF THE CONTRACT: GENERAL TERMS OF EXECUTION

The Contractor undertakes to perform a study on 'Disaster risk reduction using innovative data exploitation methods and space assets' (all hereafter referred to as "the Work") and to deliver the items under their responsibility listed in Article 2 and Appendix 1 of this Contract.

The Work shall be performed in accordance with the provisions stated in the following documents, listed in order of precedence in case of conflict:

- a) The specific articles of this Contract;
- b) Appendix 1 hereto: the European Space Agency's Statement of Work, reference EREN DTEX-EOPS-SW-14-0002, issue 1, dated 7 October, 2014;
- e) The Minutes of Meeting held 9 April, 2015 not attached hereto but known to both parties;
- d) The Contractor's proposal, reference 14121_MEMPHIS_A1_739_Proposal_vl.docx, Version V1, dated December 2014, containing the subcontractor's proposal, not attached hereto but known to the Parties;

1.3 General Terms of Execution

1.3.1 The Contractor's own sales conditions shall not apply.

1.3.2 The language of this Contract and of all communications hereunder shall be English. The substantive Law according to which this Contract shall be construed is Spanish.

1.3.3 The Parties shall use their best endeavours to amicably settle any dispute arising out of the Contract.

Failing an attempt towards an amicable settlement, all disputes shall be finally settled in accordance with the Rules of Arbitration of the International Chamber of Commerce by one or three arbitrators designated in conformity with such Rules. The Arbitration Tribunal shall sit in Madrid, Spain. The Tribunal's award shall be final, binding on the Parties and no appeal shall lie against it. The enforcement of the award shall be governed by the rules of procedure in force in the state/country in which the award is to be executed.

1.3.4 The Contractor shall be fully responsible towards the European Space Agency and ALTAMIRA for the proper execution of the Work. Sub-Contracts are expressly excluded.

1.3.5 Any publicity material prepared by the Contractor related to an activity performed by the Contractor in the context of this Contract shall acknowledge that the activity is/was carried out "under a programme of, and funded by, the European Space Agency". It shall display the ESA logo if the European Space Agency so requires. It shall also carry a disclaimer stating that the view expressed in such publications can in no way be taken to reflect the official opinion of the European Space Agency.

ARTICLE 2- DELIVERY REQUIREMENTS; PLACE AND DATE OF DELIVERY

2.1 General

2.1.1 Delivery shall be considered as effected only when the relevant deliverable items are in ALTAMIRA's possession.

2.1.2 Should it seem likely that the originally specified delivery date(s) may be exceeded, the Contractor shall immediately notify ALTAMIRA in writing and provide a detailed justification for the delay.

2.1.3 No price adjustment in favour of the Contractor will be applicable for the period of delay in delivery. No penalty to be deducted from the Contract price shall apply in case of late delivery: however, should the European Space Agency and ALTAMIRA conclude that the delays in delivery have impaired the intended objectives of the Work, the provisions of article 5.5.1.2 below shall apply.

2.1.4 The Contractor shall be responsible for the appropriate marking, packing, package labelling, insurance, freight, carriage and delivery relative to all deliverable items due hereunder and shall bear any cost relative to all of the above. Deliverable items shall furthermore be packed to guard against loss, damage or deterioration during transport and delivery. If found damaged or defective upon delivery, the European Space Agency reserves the right to return the affected items at the Contractor's expenses.

2.1.5 The acceptance by the European Space Agency of the deliverables shall be declared upon verification, by the European Space Agency, that the Work has been performed in compliance with the European Space Agency's requirements and that the required results have been achieved. The said deliverables shall be considered as accepted in the absence of an explicit reaction in respect to the same, by the European Space Agency, within one calendar month counting from the time of submission for acceptance. The provisions of article 5.5.1.1 below shall apply in this respect.

2.2 Deliverable Documents

The Contractor shall, during the performance of this Contract, deliver all documentation and reports specified in Appendix 1, in the format and quantities specified therein.

These shall be sent to ALTAMIRA Technical Officer mentioned in Article 5, unless otherwise specified, in accordance with the following specific provisions:

2.2.1 The draft versions of the final documents as defined in Appendix 1 shall be submitted for approval, in electronic format, to ALTAMIRA Technical Officer specified herein, not later than 23 August, 2016.

The finalised versions thereof shall be issued not later than four (4) weeks after the approval of the draft versions, as specified in Appendix 1.

ARTICLE 3 - PRICE

3.1 The total price of this Contract amounts to:

60,210.40 EUR

(Sixty thousand two hundred and ten Euro and forty cents)

The abovementioned price is hereby defined as a Firm Fixed Price and as such, it shall not be subject to any adjustment or revision by reason of the actual costs incurred by the Contractor in the performance of this Contract.

3.2 Any amount stated above does not include any added value taxes or import duties in the Member States of the European Space Agency.

3.3 The price is stated as being "Delivery Duty Paid" (DDP) for all deliverables, exclusive of import duties and VAT in accordance with the Incoterms 2010, to the addressee(s) mentioned, or referred to, in Article 5 of this Contract. Reference to the INCOTERMS in this provision is exclusively for the purpose of price definition.

The price furthermore includes all costs relative to the Contractor's obligations under 2.1.4 above.

ARTICLE 4- PAYMENTS AND INVOICING

4.1 Payments

Payments shall first be made to the Main contractor by the European Space Agency within thirty (30) calendar days of receipt at ESA-ESRIN Finance Payment Office of the required documents and fulfilment of the requirements specified in articles 4.1.1 - 4.1.3 below. Only upon fulfilment of these requirements shall the European Space Agency regard the invoice as due to the Main contractor.

Once the Main contractor receives the payment from the European Space Agency, the Main contractor will pay to the Contractor within ten (10) working days if all requirements listed below are fulfilled.

Requirements to be fulfilled:

4.1.1 Advance Payment:

- Advance Payment Request (APR): to be submitted after signature of this Contract by both Parties. The advance payment constitutes a debt of the Contractor to the Main Contractor until it has been set-off against subsequent milestones as shown in article 4.2 here below. The advance payment shall nominally be set-off against the 1st progress payment and the remaining amount, if any, against the next following milestone(s).

4.1.2 Progress Payment:

- Milestone Achievement Confirmation (MAC) (hereinafter referred to as "confirmation") with supporting documentation as necessary, submitted by the Contractor;
- Invoice;
- Actual achievements of the milestones as defined in the Payment Plan specified in article 4.2 here below.

4.1.3 Final Settlement:

- Confirmation, submitted by the Contractor;
- Invoice;
- Receipt and acceptance, by ALTAMIRA and the European Space Agency, of all deliverables and fulfilment of all other obligations in accordance with the terms of this Contract;
- The Contract Closure Documentation using the template provided in Appendix 1, Annex A.

Payments shall be made according to the provisions hereunder:

4.1.4 The European Space Agency shall credit the account of the Main Contractor to the Main Contractor's benefit and to the benefit of the Subcontractor(s). The Main Contractor shall be responsible for paying the accounts of its Subcontractor(s), for this Contract, within ten (10) working days.

4.1.5 If applicable, invoices shall separately show all due taxes or duties.

4.1.6 In the event that the achievement of a milestone is delayed but the milestone is partially met at the milestone planning date foreseen, the Main Contractor may as an exception, effect a payment against an approved confirmation of the partially achieved milestone, not exceeding the value of the Work performed at the date of payment and only if the European Space Agency approved the payment of the partially achieved milestone

4.1.7 All invoices shall include:

- A reference mentioning the complete number of the contract,
- The title of the event for which payment is requested (number, date of contractual phase, amount)
- VAT identification code of ALTAMIRA (ES-B62098330)
- VAT identification code of the contractor

In the absence of details identifying them clearly, requests for advance payments and invoices shall be returned to the Subcontractor.

4.1.8 Payments shall be made by the Main Contractor in EURO to the account specified by the Contractor. Such account information shall clearly indicate the IBAN (International Bank Account Number) and BIC/SWIFT (Bank Identification Code). The Parties agree that payments shall be considered as effected by the Main Contractor on time if the orders of payment reach the Main Contractor's bank within the payment period stipulated in article 4.1 above.

4.1.9 Any special charges related to the execution of payments shall be borne by the Contractor.

4.2 The following payment plan is agreed for this Contract:

| Milestone (MS) Description | Schedule Date | Payment from Main Contractor to Subcontractor |
|--|---------------|---|
| Progress (MS1): Upon successful completion of D1.1 Version 1 | October 2015 | 24,084.16€ |
| Progress (MS2): Upon successful completion of D4 Version 1 | April 2016 | 18,063.12€ |
| Final Settlement (M3): Upon the ESA acceptance of all deliverable items due under the Contract and the Contractor's fulfilment of all other contractual obligations including submission of the Contract Closure Documentation | October 2016 | 18,063.12€ |
| TOTAL: | | 60,210.40€ |

Advance Payment and other Financial Conditions

| Company Name | Advance Payment EURO | Offset against | Condition |
|--------------|----------------------|----------------|--|
| CNR-IRPI | 9,301.56 | MS1 | Upon signature of contract by both parties |

ARTICLE 5 - SPECIFIC PROVISIONS

5.1 Approval / Representatives of the Parties during Contract Execution

For the purpose of this Contract the authorised representative of ALTAMIRA INFORMATION is: Mr Alain ARNAUD, CEO

5.1.1 All correspondence for ALTAMIRA shall be addressed as follows:

ALTAMIRA INFORMATION SLU

Corsega 381-387

E-08037 Barcelona

SPAIN

a) for technical matters to: Mrs. Fifame Koudogbo
Tel: + +34 93 183 57 50
Fax: + +34 93 183 57 59
E-mail: fifame.koudogbo@altamira-information.com

with copy to Mrs. Maite Garcia
E-mail: maite.garcia@altamira-information.com

b) for contractual and administrative matters to: Mr. Alain Arnaud
Tel: + +34 93 183 57 50
Fax: + +34 93 183 57 59
E-mail: alain.arnaud@altamira-information.com

with copy to Mrs. Maite Garcia

E-mail: maite.garcia@altamira-information.com

5.1.2 Contractor's Representatives:

All correspondence for the Contractor shall be addressed as follows:

Istituto di Ricerca per la Protezione idrogeologica
Consiglio Nazionale delle Ricerche (IRPI-CNR)
Via della Madonna Alta 126
062128 Perugia
Italy

a) for technical matters to: Francesca Ardizzone

Tel: +39 075 5014 410

Fax: +39 075 5014 420

E-mail: francesca.ardizzone@irpi.cnr.it

CC: Alessandro Mondini

E-mail alessandro.mondini@irpi.cnr.it

b) for contractual and administrative matters to: Antonio Cirielli

Tel: +39 075 5014 411

Fax: +39 075 5014 420

E-mail: antonio.cirielli@irpi.cnr.it

CC Paola Cianchelli

E-mail paola.cianchelli@irpi.cnr.it

5.2 Infringement of the Law - Infringement of Third Party Rights

5.2.1 ALTAMIRA shall not be responsible if the Contractor infringes the laws or statutes of his country or of any other country whatsoever.

5.2.2 The Contractor shall indemnify ALTAMIRA and the European Space Agency from and against all claims, proceedings, damages, costs and expenses arising from infringement or alleged infringement of any patent rights and other Intellectual Property Rights of Third Parties with respect to the Work under this Contract. This obligation does not extend to infringements resulting from the use of documents, patterns, drawings or items supplied by the European Space Agency or from a modification or combination of the deliverables due hereunder made by the European Space Agency after their acceptance.

5.3 Liabilities

5.3.1 Claims between the contracting parties in respect of damages to staff and goods occurring during the execution of the Contract shall be settled in the following manner:

5.3.1.1 Claims for injuries, including death, sustained by the contracting parties' representatives or employees (staff) by virtue of their involvement in the Contract shall be settled in accordance with the law governing the Contract.

5.3.1.2 Claims for damage caused by one of the contracting parties to goods owned by the other contracting party shall be settled in accordance with the law governing the Contract.

The liability of either party for damage to goods owned by the other party, except in cases of gross negligence or wilful misconduct, shall however not exceed the amount which is quoted in the Contract as the total contract price.

5.3.2 Except in case of gross negligence and wilful misconduct, the contracting parties shall not be liable towards each other for consequential damages sustained by the parties, arising from and during the execution of the Contract. For the sake of clarity and as an example, consequential damages include, but are not limited to: loss of contract, income or revenue; loss of profit or interests; loss of financing; loss of customer; loss of availability and use of facilities; loss of availability and use of employees' productivity or loss of services of such persons; loss of opportunity; loss of rental expenses.

5.5 ALTAMIRA/ European Space Agency's Rights in Case of Contractor's Under-Performance

5.5.1.1 Should any of the results of the Work fail to meet the agreed requirements and/or specifications, ALTAMIRA / the Agency reserves the right to reject such results and require their resubmission following an iteration of the relevant work by the Contractor at no additional charge.

5.5.1.2 Should any of the results of the Work fail to meet any of the agreed requirements and/or specifications to such an extent as to seriously jeopardise the performance of this Contract and/or to defeat its objectives, ALTAMIRA /the Agency reserves the right to terminate this Contract.

5.5.1.3 Termination of this Contract as specified above shall entail no compensation being due to the Contractor other than a fair and reasonable price for the Work carried out, the results delivered or ready to be delivered prior to the serving of the termination notice. The price agreed in this respect may never exceed the amounts already paid hereunder at the time of serving of the termination notice.

5.6 Changes to this Contract

5.6.1 The European Space Agency through ALTAMIRA reserves the right at any time to request a change to the requirements covered by this Contract. The European Space Agency may also accept changes proposed by the Contractor through ALTAMIRA, through the Parties' representatives indicated in 5.1 above.

5.6.2 The cost impact relative to any change resulting from a request, by the European Space Agency through ALTAMIRA, to modify the requirements covered by this Contract shall be borne by the European Space Agency. The Contractor shall be responsible for the consequences and shall bear the cost of any other change.

5.6.3 When responding to change request issued by the European Space Agency or as a means to propose changes to the European Space Agency through ALTAMIRA, the Contractor shall submit a committing change proposal including a detailed quotation of the effects of the change on the contractual work, price, schedule, deliverable items and any other contractual terms and conditions.

5.6-4 Upon evaluation and acceptance by the European Space Agency of a change proposal, any amendment to this Contract shall be introduced in the form of a Rider or Contract

Change Notice (CCN) hereto. In case of rejection, the European Space Agency through ALTAMIRA shall inform the Contractor accordingly, together with the reasons for the rejection.

ARTICLE 6 – INTELLECTUAL PROPERTY RIGHTS

6.1 Information to be provided by the Contractor- Protection of information

6.1.1 Information, data, reports and results arising from Work performed under this Contract shall be delivered to the European Space Agency through ALTAMIRA. The European Space Agency shall have the right to make such information, data and results available to ESA Member States participating in the Programme through which this Contract is funded ("ESA Participating States") and any persons and bodies under their jurisdiction, to use on the terms set forth in the following clauses.

6.1.2 For the purpose of this Contract "Commercially Sensitive Information" shall mean information corresponding to Intellectual Property Rights vesting in an entity, the uncontrolled dissemination of which is likely to impair the entity's long-term ability to use and exploit the said Intellectual Property Rights and/or to maintain a competitive advantage.

The Contractor shall not mark any document as "Commercially Sensitive Information", unless agreed in advance with the European Space Agency through ALTAMIRA. Any request from the Contractor shall be submitted accompanied by an appropriate justification.

6.1.3 Neither Party shall disclose any documentation obtained from the other Party, and which both Parties recognise as being "Commercially Sensitive Information" without the other Party's previous written authorisation, unless the "Commercially Sensitive Information" concerned is to be provided by ALTAMIRA to the European Space Agency. Without prejudice to the foregoing and limited to the purpose and scope of this Contract, both Parties may circulate such documentation to their employees or collaborators that require the said documentation for the sole purpose of complying with, or inspecting the progress of, this Contract.

6.2 Ownership and Use of Intellectual Property Rights

6.2.1 The Contractor shall own all Intellectual Property Rights and have the right to apply for, and to own, any registered Intellectual Property Rights arising from work performed under this Contract. He shall as soon as possible report to the European Space Agency any results arising from such a work which may in his opinion be protected as registered Intellectual Property Rights and state whether he intends to apply for such protection. At the Contractor's specific request in order to allow for filing of patent applications the European Space Agency shall not disclose any relevant information and results for a period of 12 months from the date it was reported to the European Space Agency.

The Contractor shall subsequently inform the European Space Agency through ALTAMIRA of any application to register such results arising from work performed under this Contract and within 2 months of the date of filing, provide the European Space Agency through ALTAMIRA with all details on that application. The European Space Agency shall have an irrevocable right to use the information used in that application, for its own

requirements on the terms set out in article 6.2.2 below but, unless agreed otherwise with the Contractor, the European Space Agency shall not disclose such information until publication of the registration application.

6.2.2 All Intellectual Property Rights arising from work performed under the Contract shall be available to:

a) the European Space Agency, to use on a free of charge, worldwide licence, with the right to disseminate and/or to grant sub-licences, for the European Space Agency's own requirements.

When making use of its right to grant sub-licences, the European Space Agency shall endeavour to limit the scope of the licensed rights to the minimum it considers necessary to achieve the objectives of the sub-licence itself and of any contract or agreement associated with it and, accordingly, shall make available detailed design or detailed technical information (e.g. software source code, hardware blueprints, Technical Notes, etc.) only if needed.

b) ESA Participating States and any persons and bodies under their jurisdiction, to use on a free of charge, worldwide licence, without the right to grant sub-licences, for the purpose of participating to activities of the Agency.

c) ESA Participating States as well as any persons and bodies under their jurisdiction, to use on "favourable conditions" (i.e. more favourable for the purchaser than market conditions but still allowing reasonable profit for the seller) for own public requirements of such States.

d) Academic and research institutions within the ESA Participating States to use on a free licence without the right to grant sub-licences, for their own scientific research purposes, excluding commercial purposes and providing the Contractor agrees such use is not contrary to its legitimate commercial interests.

6.3 Background Intellectual Property

6.3.1 Definition

For the purpose of this Contract, "Background Intellectual Property" means all Intellectual Property, belonging to the Contractor or to a Third Party, which:

- a) has not been generated under contract with the European Space Agency either prior to or during execution of this Contract, and
- b) is relevant to the work carried out under this Contract, and
- c) the Contractor uses to achieve the objectives of this Contract, and
- d) is delivered to the European Space Agency to enable it to use, operate, copy, distribute and sub-licence the deliverable items due under this Contract as specified in the European Space Agency's requirements, and
- e) is duly identified as such in this Contract.

Conversely, "Foreground Intellectual Property" means all Intellectual Property generated through work carried out under, or for the purpose of, this Contract.

6.3.2 Use of Background Intellectual Property

The European Space Agency acknowledges that the Contractor will use Background Intellectual

Property to achieve the objectives of this Contract.

The price agreed for this Contract includes all the fees relative to access to and use of the said Background Intellectual Property, by the European Space Agency, for the purposes set forth in this Contract.

Any deliverable documents and reports containing Background Intellectual Property shall consist of distinct, appropriately marked and separable parts or volumes in order to precisely identify and segregate the Background Intellectual Property itself.

In regard to non-document deliverable items, as far as practicable and unless contrary to the European Space Agency's technical and/or delivery requirements, the Contractor may opt to deliver the Background Intellectual Property in a "protected format", provided that the interfaces between the protected Background and the Foreground parts of the relevant deliverable item are fully and thoroughly documented, the deliverable item itself is fully functional as per the European Space Agency's requirements and that, following delivery and acceptance, the European Space Agency is thus enabled to autonomously use, operate, modify and make available the deliverable item as it sees fit.

For the avoidance of doubt, "protected format" means a format which renders detailed design information not readily decipherable and/or meaningful through normal use or inspection.

The Background Intellectual Property to be used is identified as follows:

| TITLE | NATURE | PROTECTED FORMAT | OWNER |
|---|------------|---------------------|-------------|
| EO Data | | | |
| ENVISAT | EO Data | N | ESA |
| S1 /S2 | EO Data | N | ESA |
| ALOS-1/ALOS2 | EO Data | N | JAXA |
| Rapid Eye | EO Data | N | RapidEye AG |
| Additional data | | | |
| Stereoscopic aerial photographs for no-EO data Collazzone | no-EO data | N | CNR |
| Satellite images Collazzone | no-EO data | N | CNR |
| Geomorphological landslide inventory map | no-EO data | N | CNR |
| Multitemporal landslide inventory map | no-EO data | N | CNR |
| Event landslide inventory map | no-EO data | N | CNR |
| DEM | no-EO data | N | CNR |
| Land use map | no-EO data | N | CNR |
| Geological map | no-EO data | N | CNR |
| Litological map | no-EO data | N | CNR |
| Structural domains map | no-EO data | N | CNR |
| GPS data | no-EO data | N | INGV |

| | | | |
|---|------------|---|---------------------------------------|
| Seismicity | no-EO data | N | INGV |
| Fault map | no-EO data | N | INGV |
| PSI derived historical deformation map (ERS & ENVISAT) | no-EO data | N | INGV |
| Geological map | no-EO data | N | INGV |
| Landslides geodatabase | no-EO data | N | IGME |
| Landslides Technical Reports | no-EO data | N | IGNE |
| Geological maps | no-EO data | N | IGME |
| GPS data | no-EO data | N | University Patras |
| Inclinometer measurements | no-EO data | N | University Patras |
| Geological map | no-EO data | N | Open access |
| Digital elevation model | no-EO data | N | Open access |
| Geotectonic Data (Faults, lineaments etc.) | no-EO data | N | Open access |
| Seismic Data of the broader area (Revised Earthquake Catalogue) | no-EO data | N | Open access |
| <i>Focal Source Parameters</i> of the M>4 seismic events during the last decade | no-EO data | N | Open access |
| GPS Data from Continuous stations (TS) | no-EO data | N | Open access |
| GPS from campaign data (deformation vectors, velocities) | no-EO data | N | Available only for use in the project |
| GPS daily data 30s from the Continuous stations | no-EO data | N | Open access |
| Revised Earthquake catalogue | no-EO data | N | Open access |
| Source parameters of seismic events (M>4) | no-EO data | N | Open access |

The Background Intellectual Property owned by the Contractor or a Third Party shall remain the property of the owner.

Background Intellectual Property to which the European Space Agency requires access for the sole purpose of technical or legal inspection during the execution of this Contract shall be treated as "Commercially Sensitive Information" as set forth under 6.1.2 and 6.1.3 above.

The following conditions shall apply to Background Intellectual Property which the Contractor delivers together with, or as part of, the deliverable items due under this Contract:

a) For Background Intellectual Property delivered in a format making it readily decipherable and meaningful by inspecting, accessing or using the said deliverable items:

The Contractor shall grant to the European Space Agency, or ensure that the Agency be granted, an irrevocable, free, world-wide licence to enable the Agency to autonomously use, operate, copy, modify and sub-license the Background Intellectual Property limited to its own requirements relative to this Contract and/or the projects or activities listed under ii) below;

b) For Background Intellectual Property delivered in protected format:

The Contractor shall grant the Agency, or ensure that the Agency be granted, an irrevocable, free, world-wide licence to enable the Agency to autonomously use, copy, distribute and sub-licence, without any restrictions, the Background Intellectual Property delivered in protected format under this Contract as part of other deliverable items;

The Contractor shall grant the Agency, or ensure that the Agency be granted, an irrevocable, free, world-wide licence to enable the Agency to autonomously use, operate, copy, distribute and sub- licence the Background Intellectual Property delivered in protected format as a separate item under this Contract, limited to the Agency's own requirements relative to this Contract and/or the projects or activities listed under a) ii. above.

The Agency shall not decrypt, decompile or reverse-engineer Background Intellectual Property delivered in protected format and shall reflect this obligation onto any (sub)licence or agreement into which it may enter to further distribute to any Third Party the said Background Intellectual Property as the Agency sees fit.

6.4 Transfer outside the ESA Member States

6.4.1 The Contractor shall inform the Agency through ALTAMIRA in writing prior to any intended transfer to any entity in a non-Member State of the Agency or any international organisation of Intellectual Property Rights or any product, process, application or result arising from work performed under the Contract.

6.4.2 The notification shall include the following information:

- the proposed transferee or licensee outside the ESA Member States;
- the terms of the intended transfer or licence (together with all countries of destination) and the intended use of the subject matter to be transferred or licensed;
- all relevant national approval procedures which need to be obtained to comply with national legislation, including a statement concerning approvals applied for or granted.

The Agency shall only disclose the information on a need to know basis to its staff and the members of the Agency's Technology and Product Transfer Board.

6.4.3 The request for a transfer outside the Member States shall be addressed to the Agency's Technology and Product Transfer Board via the Secretary of the Board, Legal Department, ESA Headquarters, 8-10 rue Mario-Nikis, 75015 Paris, with a copy to the Main Contractor's technical and administrative representatives identified in Article 5.1.1a) and b) above.

6.4.4 Before entering into any unconditional commitment relative to the transfer, the Contractor shall allow 5 weeks from submission of his written notification to the Agency.

In the absence of an explicit recommendation to the contrary within the abovementioned time limit, a favourable recommendation may be assumed.

Done and signed in two (2) original copies, one for each party to the Contract,

On behalf of ALTAMIRA INFORMATION SLU

On behalf of the Contractor

In Barcelona

In.....*Perugia*.....

on this day*June 26th, 2015*.....

on this day*June 29th, 2015*.....

.....
Mr. Alain ARNAUD
Chief Executive Officer

.....
Dr. Fausto Guzzetti
Director of the CNR Research Institute for
Geo-Hydrological Protection (IRPI),

ALTAMIRA
INFORMATION

CIF: B 62098330
Còrsega, 381-387
E-08037 Barcelona



IL DIRETTORE
Dott. Fausto Guzzetti

APPENDIX 1: STATEMENT OF WORK



ESA Contract No. 4000113774/15/F/MOS
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APPENDIX 1

STATEMENT OF WORK



esrin

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. DRR 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_digital.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 initiative 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 trough 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).

2



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 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 discernable 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).

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- 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. A 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.

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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.

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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+18months 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 | EUR |
| and total contract value <i>(in case of co-funding; state if not applicable)</i> | 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 (title, description) | Owner (Contractor, Sub-Contractor(s), third party/ies) | Affected deliverable (which documents, hardware, software, etc.) | Description impact on ESA's rights to the deliverable ¹⁾ | Other/comments |
|---|--|---|--|----------------|
| | | | | |

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

[Handwritten signature]



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*):

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



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

| | | |
|--------------------------|---|-------------------------------------|
| <input type="checkbox"/> | 1 | Earth Observation |
| <input type="checkbox"/> | 2 | Science |
| <input type="checkbox"/> | 3 | Human Spaceflight and Exploration |
| <input type="checkbox"/> | 4 | Space Transportation |
| <input type="checkbox"/> | 5 | Telecommunications |
| <input type="checkbox"/> | 6 | Navigation |
| <input type="checkbox"/> | 7 | Generic Technologies and Techniques |
| <input type="checkbox"/> | 8 | Security |
| <input type="checkbox"/> | 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 customers 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]

APPENDIX B to STATEMENT OF WORK**Project Deliverable List**

| Item# | Name | WP | Type | Lead | Contributors | Due* |
|-------|---|--------|----------|------|-----------------------|---------|
| D1.1 | Assessment of user requirements DRAFT | WP1000 | Report | CNR | INGV, NKUA, IGME | KO+3M |
| D1.1 | Assessment of user requirements VERSION 1 | WP1000 | Report | CNR | INGV, NKUA, IGME | KO+6M |
| D1.1 | Assessment of user requirements VERSION 2 | WP1000 | Report | CNR | INGV, NKUA, IGME | KO+18M |
| D2.1 | Assessment of the contribution of new space & IT solutions to support DRR DRAFT | WP2000 | Report | TDUE | ALTA, INGV, CNR | KO+4M |
| D2.1 | Assessment of the contribution of new space & IT solutions to support DRR VERSION 1 | WP2000 | Report | TDUE | ALTA, INGV, CNR | KO+12 M |
| D2.1 | Assessment of the contribution of new space & IT solutions to support DRR VERSION 2 | WP2000 | Report | TDUE | ALTA, INGV, CNR | KO+18M |
| D3.1 | Consultation Planning Document | WP3000 | Document | ALTA | CNR | KO+3M |
| D3.2 | Report of consultation meeting | WP3000 | Report | ALTA | CNR | KO+5M |
| D3.3 | Report of the readiness review of the trial cases | WP3000 | Report | ALTA | CNR, INGV, NKUA, IGME | KO+5M |
| D4.1 | Report of trial cases VERSION 1 | WP4000 | Report | ALTA | CNR, INGV, NKUA, IGME | KO+12M |
| D4.1 | Report of trial cases VERSION 2 | WP4000 | Report | ALTA | CNR, INGV, NKUA, IGME | KO+15M |
| D4.1 | Report of trial cases VERSION 3 | WP4000 | Report | ALTA | CNR, INGV, NKUA, IGME | KO+18M |
| D4.2 | User Utility Report VERSION 1 | WP4000 | Report | ALTA | NKUA, IGME | KO+12M |
| D4.2 | User Utility Report VERSION 2 | WP4000 | Report | ALTA | NKUA, IGME | KO+15M |
| D4.2 | User Utility Report VERSION 3 | WP4000 | Report | ALTA | NKUA, IGME | KO+18M |
| D5.1 | Report of the assessment of requirements DRAFT | WP5000 | Report | CNR | CNR, INGV, NKUA, IGME | KO+6M |
| D5.1 | Report of the assessment of requirements VERSION 1 | WP5000 | Report | CNR | CNR, INGV, NKUA, | KO+12M |

| | | | | | | |
|------|---|--------|----------|------|--------------------------------|--------|
| | | | | | IGME | |
| D5.1 | Report of the assessment of requirements VERSION2 | WP5000 | Report | CNR | CNR, INGV, NKUA, IGME | KO+18M |
| D5.2 | Report of the capability of EO missions to contribute to DRR DRAFT | WP5000 | Report | ALTA | DLR | KO+6M |
| D5.2 | Report of the capability of EO missions to contribute to DRR VERSION 1 | WP5000 | Report | ALTA | DLR | KO+12M |
| D5.2 | Report of the capability of EO missions to contribute to DRR VERSION 2 | WP5000 | Report | ALTA | DLR | KO+18M |
| D5.3 | Report of the gap analysis concerning space assets to support DRR DRAFT | WP5000 | Report | DLR | ALTA | KO+6M |
| D5.3 | Report of the gap analysis concerning space assets to support DRR VERSION 1 | WP5000 | Report | DLR | ALTA | KO+12M |
| D5.3 | Report of the gap analysis concerning space assets to support DRR VERSION 2 | WP5000 | Report | DLR | ALTA | KO+18M |
| DF.1 | Final Report | WP6000 | Report | ALTA | - | |
| DF.2 | Executive Summary | WP6000 | Document | ALTA | - | |
| DF.3 | Contract closure documentation | WP6000 | Document | ALTA | - | |

* M = months