Horizon 2020

Call: H2020-EINFRA-2016-2017
(E-Infrastructures)

Topic: EINFRA-22-2016

Type of action: RIA
(Research and Innovation action)

Proposal number: 730932

Proposal acronym: HYEEA

Deadline Id: H2020-EINFRA-2016-1
Table of contents

Section	*Title*	*Action*
1	General information	
2	Participants & contacts	
3	Budget	
4	Ethics	
5	Call-specific questions	

How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **730932** *Acronym* **HYEEA**

1 - General information

Topic	EINFRA-22-2016
Call Identifier	H2020-EINFRA-2016-2017
Type of Action	RIA
Deadline Id	H2020-EINFRA-2016-1

Acronym: HYEEA

Proposal title*: HYdrometeorological e-Infrastructure for Environmental Applications

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months: *36*

Free keywords: *natural hazards, data, services, socio-economical impacts, researchers, public administrations, SMEs*

Abstract

HYEEA (HYdrometeorological e-Infrastructure for EnvironmentalvApplications) aims to develop an e-Infrastructure supporting key European initiatives to meet new challenges in the disaster risk management (DRM) cycle of natural hazards, through the prototyping of innovative data and computing intensive services.

Building on research and operational projects such as DRIHM (Distributed Research Infrastructure for Hydro-Meteorology, www.drihm.eu), RASOR (Rapid Analysis and Spatialisation Of Risk, www.rasor-project.eu), ESA TEP Hydrology (https://hydrology-tep.eo.esa.int/#!) and ESA TEP Geohazards (https://geohazards-tep.eo.esa.int/#!) as well as on JRC DRM platforms, such as EFAS (www.efas.eu/about-efas.html), EFFIS (/forest.jrc.ec.europa.eu/effis/) and EDO (edo.jrc.ec.europa.eu/), this project will help:
supporting EU societal challenges with emphasis on natural hazards, such as flash-flood, forest fires and droughts, prevention and prediction from short-range to up-to seasonal timescale; fast prototyping of innovative DRM computing and intensive services, on top of global e-Infrastructures for the study, evaluation, prediction of natural hazards and their social/economic/environmental impacts; standardisation leading to economies of scale that facilitate access to and uptake of DRM resources and facilitate new inter- and transdisciplinary collaborations between adjacent, but not connected, scientific communities (Hydrology, Meteorology, Hydraulics, Climatology, Remote Sensing, and Information and Communication Technologies); drastically lower the access threshold to DRM data and computing resources, thus enabling their exploitment by profit-making users (e.g. SMEs), public admininistrations (PAs) users, and research users

Remaining characters 249

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under the 7th Framework Programme, Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **730932** *Acronym* **HYEEA**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on http://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html or to be covered by a financial viability check in an EU project for the last closed financial year. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	◉
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	○
- as sole participant in the proposal is exempt from the financial capacity check.	○

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him/her and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection

Your reply to the grant application will involve the recording and processing of personal data (such as your name, address and CV), which will be processed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the processing of your personal data are available on the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Warning System (EWS) only or both in the EWS and Central Exclusion Database (CED) by the Accounting Officer of the Commission, should you be in one of the situations mentioned in:
-the Commission Decision 2008/969 of 16.12.2008 on the Early Warning System (for more information see the Privacy Statement), or
-the Commission Regulation 2008/1302 of 17.12.2008 on the Central Exclusion Database (for more information see the Privacy Statement) .

Proposal ID **730932** *Acronym* **HYEEA**

List of participants

#	Participant Legal Name	Country
1	Centro Internazionale in Monitoraggio Ambientale - Fondazione CIMA	Italy
2	LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN	Germany
3	CONSIGLIO NAZIONALE DELLE RICERCHE	Italy
4	EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS	United Kingdom
5	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	Spain
6	TERRADUE SRL	Italy
7	ALTAMIRA INFORMATION SL	Spain

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **Fondazione CIMA**

2 - Administrative data of participating organisations

PIC	***Legal name***
997710476	*Centro Internazionale in Monitoraggio Ambientale - Fondazione CIMA*

Short name: Fondazione CIMA

Address of the organisation

Street Via A. Magliotto 2

Town Savona

Postcode 17100

Country Italy

Webpage www.cimafoundation.org

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Legal person ..... yes
Non-profit ..... yes
International organisation ..... unknown
International organisation of European interest ..... unknown
Secondary or Higher education establishment ..... no
Research organisation ..... yes

Enterprise Data

SME self-declared status ..... unknown
SME self-assessment ..... unknown
SME validation sme ..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: 721 - Research and experimental development on natural sciences and engineering

Proposal ID **730932**	*Acronym* **HYEEA**	*Short name* **Fondazione CIMA**

Department(s) carrying out the proposed work

No departement involved

Department name ☒ not applicable

☐ Same as organisation address

Street *Please enter street name and number.*

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **Fondazione CIMA**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Antonio** Last name: **PARODI**

E-Mail: **antonio.parodi@cimafoundation.org**

Position in org.: Research Director

Department: Centro Internazionale in Monitoraggio Ambientale - Fondazione CIM ☒ Same as organisation

☒ Same as organisation address

Street: Via A. Magliotto 2

Town: Savona Post code: 17100

Country: Italy

Website:

Phone 1: +xxx xxxxxxxxx Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **LMU MUENCHEN**

PIC	***Legal name***
999978433	*LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN*

Short name: LMU MUENCHEN

Address of the organisation

Street GESCHWISTER SCHOLL PLATZ 1

Town MUENCHEN

Postcode 80539

Country Germany

Webpage www.uni-muenchen.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... unknown

International organisation of European interest ..... unknown

Secondary or Higher education establishment ..... yes

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status ..... 2014 - no

SME self-assessment ..... unknown

SME validation sme ..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: 853 - Higher education

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **LMU MUENCHEN**

Department(s) carrying out the proposed work

Department 1

Department name: Institut für Informatik ☐ not applicable

☐ Same as organisation address

Street: Oettingenstr. 67

Town: München

Postcode: 80538

Country: Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **LMU MUENCHEN**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Dieter** Last name: **Kranzlmueller**

E-Mail: **kranzlmueller@ifi.lmu.de**

Position in org.: Full Professor

Department: Institut für Informatik ☐ Same as organisation

☐ Same as organisation address

Street: Oettingenstr. 67

Town: München Post code: 80538

Country: Germany

Website: http://www.nm.ifi.lmu.de

Phone 1: +49-89-2180-9146 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **CNR**

PIC	***Legal name***
999979500	*CONSIGLIO NAZIONALE DELLE RICERCHE*

Short name: CNR

Address of the organisation

Street PIAZZALE ALDO MORO 7

Town ROMA

Postcode 00185

Country Italy

Webpage www.cnr.it

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status ..... 2015 - no

SME self-assessment ..... unknown

SME validation sme ..... 2007 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: 721 - Research and experimental development on natural sciences and engineering

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **CNR**

Department(s) carrying out the proposed work

Department 1

Department name: Institute for Applied Mathematics and Information Technologies ☐ not applicable

☐ Same as organisation address

Street: Via dei Marini, 6

Town: Genoa

Postcode: 16149

Country: Italy

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **CNR**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Andrea** Last name: **Clematis**

E-Mail: **clematis@ge.imati.cnr.it**

Position in org.: Section Head

Department: CONSIGLIO NAZIONALE DELLE RICERCHE ☒ Same as organisation

☐ Same as organisation address

Street: Via dei Marini 6

Town: Genoa Post code: 16149

Country: Italy

Website: http://www.imati.cnr.it/index.php/genova

Phone 1: Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **ECMWF**

PIC	***Legal name***
999916741	*EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS*

Short name: ECMWF

Address of the organisation

Street SHINFIELD PARK

Town READING

Postcode RG2 9AX

Country United Kingdom

Webpage www.ecmwf.int

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... yes

International organisation of European interest ..... yes

Secondary or Higher education establishment ..... no

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status..... unknown

SME self-assessment ..... unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: - - Not applicable

Proposal ID **730932**	*Acronym* **HYEEA**	*Short name* **ECMWF**

Department(s) carrying out the proposed work

Department 1

Department name	Forecast Department	☐ not applicable
	☒ Same as organisation address	
Street	SHINFIELD PARK	
Town	READING	
Postcode	RG2 9AX	
Country	United Kingdom	

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **ECMWF**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Florian** Last name: **Pappenberg**

E-Mail: **florian.pappenberger@ecmwf.int**

Position in org.: Senior Scientist

Department: Forecast Department ☐ Same as organisation

☒ Same as organisation address

Street: SHINFIELD PARK

Town: READING Post code: RG2 9AX

Country: United Kingdom

Website: www.ecmwf.int

Phone 1: +441189499 830 Phone 2: +xxx xxxxxxxxx Fax: +441189869450

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
daniel	Thiemert	daniel.thiemert@ecmwf.int	+441189499024
Calum	Baugh	calum.baugh@ecmwf.int	+441189499225
Ben	Brown	ben.brown@ecmwf.int	+441189499211
Laura	Drion	laura.drion@ecmwf.int	+441189499216

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **BSC**

PIC	***Legal name***
999655520	*BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION*

Short name: BSC

Address of the organisation

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status ..... 2011 - no

SME self-assessment ..... unknown

SME validation sme ..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: 72 - Scientific research and development

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **BSC**

Department(s) carrying out the proposed work

Department 1

Department name: Earth Science Deparment ☐ not applicable

☐ Same as organisation address

Street: Calle Jordi Girona 29, NEXUS II

Town: Barcelona

Postcode: 08034

Country: Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **BSC**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Kim** Last name: **Serradell**

E-Mail: **kim.serradell@bsc.es**

Position in org.: COMPUTATIONAL EARTH SCIENCES GROUP COORDINATOR

Department: BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SU ☒ Same as organisation

☒ Same as organisation address

Street: Calle Jordi Girona 31

Town: BARCELONA Post code: 08034

Country: Spain

Website:

Phone 1: +xxx xxxxxxxxx Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Albert	Soret	albert.soret@bsc.es	+34934134076
Mar	Rodriguez	mar.rodriguez@bsc.es	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **TERRADUE**

PIC	***Legal name***
999732829	*TERRADUE SRL*

Short name: TERRADUE

Address of the organisation

Street VIA G. LUNATI 10

Town FRASCATI

Postcode 00044

Country Italy

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Legal person ..... yes

Enterprise Data

SME self-declared status ..... 2009 - yes
SME self-assessment ..... unknown
SME validation sme ..... 2008 - yes

Based on the above details of the Beneficiary Registry the organisation is an SME (small- and medium-sized enterprise) for the call.

NACE Code: - - Not applicable

Proposal ID **730932**	*Acronym* **HYEEA**	*Short name* **TERRADUE**

Department(s) carrying out the proposed work

No departement involved

Department name ☒ not applicable

☐ Same as organisation address

Street *Please enter street name and number.*

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **TERRADUE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Fabrice** Last name: **Brito**

E-Mail: **fabrice.brito@terradue.com**

Position in org.: CEO

Department: TERRADUE SRL ☒ Same as organisation

☒ Same as organisation address

Street: VIA G. LUNATI 10

Town: FRASCATI Post code: 00044

Country: Italy

Website:

Phone 1: +xxx xxxxxxxxx Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **ALTAMIRA**

PIC	***Legal name***
998860896	*ALTAMIRA INFORMATION SL*

Short name: ALTAMIRA

Address of the organisation

Street C CORSEGA 381-387

Town BARCELONA

Postcode 08037

Country Spain

Webpage www.altamira-information.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no

Non-profit ..... no

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... no

Legal person ..... yes

Enterprise Data

SME self-declared status ..... 2007 - no

SME self-assessment ..... unknown

SME validation sme ..... 2007 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

NACE Code: 93 - Sports activities and amusement and recreation activities

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **ALTAMIRA**

Department(s) carrying out the proposed work

No departement involved

Department name ☒ not applicable

☐ Same as organisation address

Street *Please enter street name and number.*

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **730932** *Acronym* **HYEEA** *Short name* **ALTAMIRA**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: ○ Male ◉ Female

First name: **Patricia** Last name: **Hidalgo**

E-Mail: **patricia.hidalgo@altamira-information.com**

Position in org.: Financial Manager

Department: ALTAMIRA INFORMATION SL ☒ Same as organisation

☒ Same as organisation address

Street: C CORSEGA 381-387

Town: BARCELONA Post code: 08037

Country: Spain

Website:

Phone 1: Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	*Last Name*	*E-mail*	*Phone*
Laia	Romero	laia.romero@altamira-information.com	

Proposal ID **730932** *Acronym* **HYEEA**

3 - Budget for the proposal

No	Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution / € (=H*I)	(K) Requested EU Contribution/ €
1	Fondazione Cima	IT	510000	34000	0	0	0	136000,00	0	680000,00	100	680000,00	680000,00
2	Lmu Muenchen	DE	296800	25500	0	0	0	80575,00	0	402875,00	100	402875,00	402875,00
3	Cnr	IT	338067	10200	0	0	0	87066,75	0	435333,75	100	435333,75	435333,75
4	Ecmwf	UK	312791	16949	0	0	0	82435,00	0	412175,00	100	412175,00	412175,00
5	Bsc	ES	308000	25500	0	0	0	83375,00	0	416875,00	100	416875,00	416875,00
6	Terradue	IT	313650	12750	0	0	0	81600,00	0	408000,00	100	408000,00	408000,00
7	Altamira	ES	180765	6600	0	0	0	46841,25	0	234206,25	100	234206,25	234206,25
	Total		2260073	131499	0	0	0	597893,00	0	2989465,00		2989465,00	2989465,00

Proposal ID **730932** *Acronym* **HYEEA**

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	○ Yes ◉ No	
6. THIRD COUNTRIES		**Page**
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	○ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	○ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU? *For data imports, please fill in also section 4.* *For imports concerning human cells or tissues, fill in also section 3.*	○ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries? *For data exports, please fill in also section 4.* *For exports concerning human cells or tissues, fill in also section 3.*	○ Yes ◉ No	

Proposal ID **730932** *Acronym* **HYEEA**

If your research involves low and/or lower middle income countries, are benefits-sharing actions planned?	◯ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	◯ Yes ◉ No	
7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants? *For research involving animal experiments, please fill in also section 5.*	◯ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	◯ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff? *For research involving human participants, please fill in also section 2.*	◯ Yes ◉ No	
8. DUAL USE		Page
Does your research have the potential for military applications?	◯ Yes ◉ No	
9. MISUSE		Page
Does your research have the potential for malevolent/criminal/terrorist abuse?	◯ Yes ◉ No	
10. OTHER ETHICS ISSUES		Page
Are there any other ethics issues that should be taken into consideration? Please specify	◯ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

How to Complete your Ethics Self-Assessment

Proposal ID **730932** *Acronym* **HYEEA**

5 - Call specific questions

Open Research Data Pilot in Horizon 2020

If selected, all applicants will participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions. Participating in the Pilot does not necessarily mean opening up all research data. Actions participating in the Pilot will be invited to formulate a Data Management Plan in which they will determine and explain which of the research data they generate will be made open.

Applicants have the possibility to opt out of this Pilot and must indicate a reason for this choice.

Participation in this Pilot does not constitute part of the evaluation process. Proposals will not be evaluated favourably because they are part of the Pilot and will not be penalised for opting out of the Pilot.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

Data management activities

The use of a Data Management Plan (DMP) is required for projects participating in the Open Research Data Pilot in Horizon 2020, in the form of a deliverable in the first 6 months of the project.

All other projects may deliver a DMP on a voluntary basis, if relevant for their research.

Are data management activities relevant for your proposed project?	◉ Yes	○ No

A Data Management Plan will be delivered (Please note: Projects participating in the Open Research Data Pilot **must** include a Data Management Plan as a deliverable in the first 6 months of the project).	☒
Data Management is part of a Work Package.	☐
Data Management will be integrated in another way.	☐

Proposal full title

HYdrometeorological e-Infrastructure for Environmental Applications

Proposal acronym

HYEEA

Topic: User-driven e-infrastructure innovation - EINFRA-22-2016

Exploitation of e-infrastructures for user-driven innovation and pilots responding to community specific challenges – POINT 1

Name of the coordinating person: Antonio Parodi (antonio.parodi@cimafoundation.org)

List of participants

Participant No	Participant organisation name	Country
1 (Coordinator)	CIMA RESEARCH FOUNDATION (CIMA)	Italy
2	LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN (LMU)	Germany
3	CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)	Italy
4	EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS (ECMWF)	United Kingdom
5	BARCELONA SUPERCOMPUTING CENTER (BSC)	Spain
6	TERRADUE (TERRA2)	Italy
7	ALTAMIRA (ALTA)	Spain

Table of Contents

1. Excellence 4
   1.1 Objectives 4
   1.2 Relation to the work programme 7
   1.3 Concept and approach 10
      1.3.1 Overall concepts underpinning this project 11
      1.3.2 System design 21
      1.3.3 Leveraging the state of the art 24
      1.3.4 Gender analysis 31
   1.4 Ambition 31
2. Impact 33
   2.1 Expected impacts 33
      2.1.1 To accelerate the development of innovative data and computing intensive services in areas of social relevance 34
      2.1.2 Bridge the gap between adjacent but not connected scientific communities 36
      2.1.3 Knowledge capital better preserved for further exploitation by future digital-born generations 36
      2.1.4 To increase the number of SMEs that are aware of available e-infrastructures resources and become active innovators as users and or suppliers 37
   2.2 Measuring the project's impact: Key Performance Indicators 37
   2.3 Measures to maximise impact 39
      2.3.1 Dissemination and exploitation of results 39
      2.3.2 Business plan (financial sustainability) 39
      2.3.3 IPR and data management 40
      2.3.4 Communication activities 42
3. Implementation 43
   3.1 Work plan – Work packages, deliverables, and milestones 45
   3.2 Management structure and procedures 63
      3.2.1 Organisational structure and decision-making mechanisms 63
      3.2.2 Quality assurance 65
      3.2.3 Conflict management and problem escalation 65
   3.3 Consortium as a whole 69
   3.4 Resources to be committed 69
4. Members of the consortium 71
   4.1 Participants (applicants) 71
      4.1.1 CIMA Research Foundation (CIMA, coordinator) 71
      4.1.2 Ludwig-Maximilians-Universität München (LMU) 72
      4.1.3 Consiglio Nazionale delle Ricercher (CNR)-IMATI 74
      4.1.4 European Centre for Medium-Range Weather Forecasts (ECMWF) 76
      4.1.5 Barcelona Supercomputing Center (BSC) 78
      4.1.6 TERRADUE (TERRA2) SRL 81
      4.1.7 ALTAMIRA INFORMATION 84
   4.2 Third parties involved in the project (including use of third party resources) 87
5. Ethics and Security 87
   5.1 Ethics 87
   5.2 Security 87

List of main acronyms

Application programming interface	API
Agenzia Regionale Per La Protezione Dell'ambiente Ligure	ARPAL
Catchment Characterisation and Modelling	CCM
Combined Drought Indicator	CDI
Copernicus Emergency Management Service	CEMS
Climate & Forecasting	CF
Computational Infrastructure Services	COMP
COnsortium for Small-scale Modelling	COSMO
Computing Services	CS
Discharge River Forecast	DRiFt
Distributed Research Infrastructure for Hydro-Meteorology	DRIHM
Disaster Risk Management	DRM
European Climate Assessment	ECA
European Centre For Medium-Range Weather Forecasts	ECMWF
European Cluster Observatory	ECO
European Drought Observatory	EDO
European Environment Agency	EEA
European Flood Awareness System	EFAS
European Forest Fire Information System	EFFIS
European Grid Infrastructure	EGI
European Institute of Innovation & Technology	EIT
Evaluation and Quality Control	EQC
European Emergency Response Coordination Centre	ERCC
European Space Agency	ESA
European Association of Databases for Education and Training	EUDAT
Fire Weather Index	FWI
Gigabit European Academic Network	GÉANT
Global Forecasting system	GFS
HYdrological cycle in the Mediterranean EXperiment	HYMEX
Information Communication Technology	ICT
Input Data Services	IS
Limited Area Model	LAM
M – Metadata, Documentation and Licence - A – Adaptors - Portability	MAP
National Center for Atmospheric Research	NCAR
National Centers for Environmental Prediction	NCEP
NOAA Environmental Modeling System	NEMS
Nonhydrostatic Multiscale Model on the Arakawa B grid	NMMB
National Oceanic and Atmospheric Administration	NOAA
Numerical Weather Prediction	NWP
Open Geospatial Consortium	OGC
Output Data Services	OS
Public Administrations	PAs
Platform Instance	PI
Partnership for Advanced Computing in Europe	PRACE
Rapid Analysis and Spatialization Of Risk	RASOR
Real-time Interactive Basin Simulator	RIBS
Fire Risk and Coordination	RISICO
Sub-seasonal to Seasonal	S2S
Small Medium Entreprise	SMS
SuperSite Exploitation Platform	SSEP
Technological Exploitation Platform	TEP
THORPEX Interactive Grand Global Ensemble	TIGGE
Technological Readiness Level	TRL
Use case	UC
Union Civil Protection Mechanism	UCPM
United Nations Office for Disaster Risk Reduction	UNISDR
Web Processing Service	WPS
Weather Research and Forecasting	WRF

1. Excellence

1.1 Objectives

HYEEA will meet new challenges in the disaster risk management (DRM) cycle of natural hazards from their onset to the subsequent social/economic/environmental impacts, through TRL8 innovative data and computing services, supporting the key DRM European initiatives

The scale of the societal challenge that climate change represents is becoming more and more evident. A 2015 research study[1] shows that a 2°C rise in global temperature – the threshold agreed in the Paris climate agreement – is still expected to lead to a significant increase in natural hazards, such as floods, flash-flood, and droughts in many regions of Europe. The climate changes expected under the 2°C degree scenario will have a significant impact on river flows in Europe. Maximum winter snowpack is expected to decrease due to global warming, while intense rainfalls are projected to increase significantly over the whole continent. Floods and flash-flood phenomena are expected to increase, particularly south of the 60°N line, and to decrease significantly in parts of Finland, Russia and Sweden (reduced snow-melt floods largely due to lower snowpack). However, floods are projected to increase in coastal parts of Norway and southern Sweden. More intense droughts are expected in much of southern Europe, the southern UK and Ireland, due to lower levels of rainfall and higher evapotranspiration, with implication also for the forest fire risk and for water resources/water quality management. These developments force any organisation dealing with hydrometeorology-related risks to reassess their assumptions, approaches and operational practices, as well as the ICT (Information Communication Technology) tools supporting them.

Recent european natural disasters such as flooding and flash-flooding in Ireland (December 2015), the UK (December 2013, 2014 and 2015), central Europe (May 2013), as well as Southern France (August 2015, October 2015, and November 2011), and north-western Italy (November 2011, and October 2015), but also 2009 Mediterranean wildfires season (France, Greece, Italy, Spain, and Turkey), as well as droughts (France, Spain, Portugal and UK winter 2012, ands outh-eastern Iberian peninsula October 2013-July 2014, France, Benelux, Germany, Hungary, the Czech Republic, northern Italy june-july 2015), are testimony to the disastrous impacts that such future natural hazards are likely to pose.

In view of its overarching objective and in order to meet the expected impacts specified by the Call, HYEEA has defined three objectives that will govern the respective activities carried out in the project and that are perfectly aligned with the specific, and documented goals of European and international Institutions and initiatives [2] such as European Emergency Response Coordination Centre (ERCC[3]), the Union Civil Protection Mechanism (UCPM[4]) legislation, and United Nations Office for Disaster Risk Reduction (UNISDR):

Objective 1: Address societal challenges through support of European initiatives, with an emphasis on natural hazards, such as flash-floods, forest fires, landslides, and droughts, prevention and prediction from short-range to up-to seasonal timescale.

HYEEA disaster risk management (DRM) services will enable a probabilistic approach to predict a wide range of natural hazards from their onset to the subsequent social/economic/environmental impacts, through multi-model and multi-data chaining on on existing and future European and global e-Infrastructures. To that end, the project proposes distinct use cases showcasing the potential of a consolidated HYEEA for coping with critical societal and economic challenges in

[1] Roudier, P., Andersson, J. C., Donnelly, C., Feyen, L., Greuell, W., & Ludwig, F. (2015). Projections of future floods and hydrological droughts in Europe under a+ 2° C global warming. Climatic Change, 1-15.
[2] The complete list of initiatives and their specific requirements the project will address are presented in sections 1.3.3 and 2.1.1.
[3] http://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/ERC_en.pdf
[4] Council Decision No. 1313/2013/EU, Official Journal of the European Union, L347, 20.12.2013

Europe, in the areas of adaptation to climate change, improved food security and water resources/water quality management.

Objective 2: Fast prototyping of innovative DRM computing and data intensive services, on top of global e-Infrastructures for the study, evaluation, prediction of severe weather scenarios and their social/economic/environmental impacts.

Access to state-of-the-art DRM prediction models and data requires an amalgam of competencies in several fields (Hydrology, Meteorology, Hydraulics, Climatology, Geology, Remote Sensing, and Information and Communication Technologies), combined with considerable amount of resources and operational services from global e-Infrastructures. The foundations for innovative DRM computing and data intensive services development will be based on mature – Technological Readiness Level (TRL) equal or above the level 8 – such as the data access and storage (EUDAT), computing power (PRACE, EGI, and HELIX NEBULA), fast connectivity (GÉANT) provided by the European initiatives. This solid foundation makes it possible to take data and models that have been used in more limited manner (TRL 6 or slightly above), adapt them quickly to a robust environment and operational practices, and in the process raise also their maturity to TRL level 8 (task WP2.4).

Building on global e-Infrastructures, HYEEA will pursue European research and operational e-Infrastructures integration (CEMS - Copernicus Emergency Management Service including EFAS - European Flood Awareness System[5], EFFIS - European Forest Fire Information System[6] - *see JRC – Joint Research Center support letter*), EDO – European Drought Observatory[7], DRIHM - Distributed Research Infrastructure for Hydro-Meteorology [8], ESA (European Space Agency) TEP (Technological Exploitation Platform) Hydrology[9] and Geohazards[10], and RASOR - Rapid Analysis and Spatialization Of Risk[11] - *see RASOR support letter*) to drastically lower the access threshold to DRM data and computing resources, thus enabling their exploitment by profit-making users (e.g. Small Medium Entreprises – SMEs, and innovators), public administrations (PAs) users, and research users (Figure 1). Last but not less important HYEAA design and implementation is expected to trigger a virtuos feedback loop, such that e-Infrastructures will benefit from running HYEEA services by studying the requirements of these applications

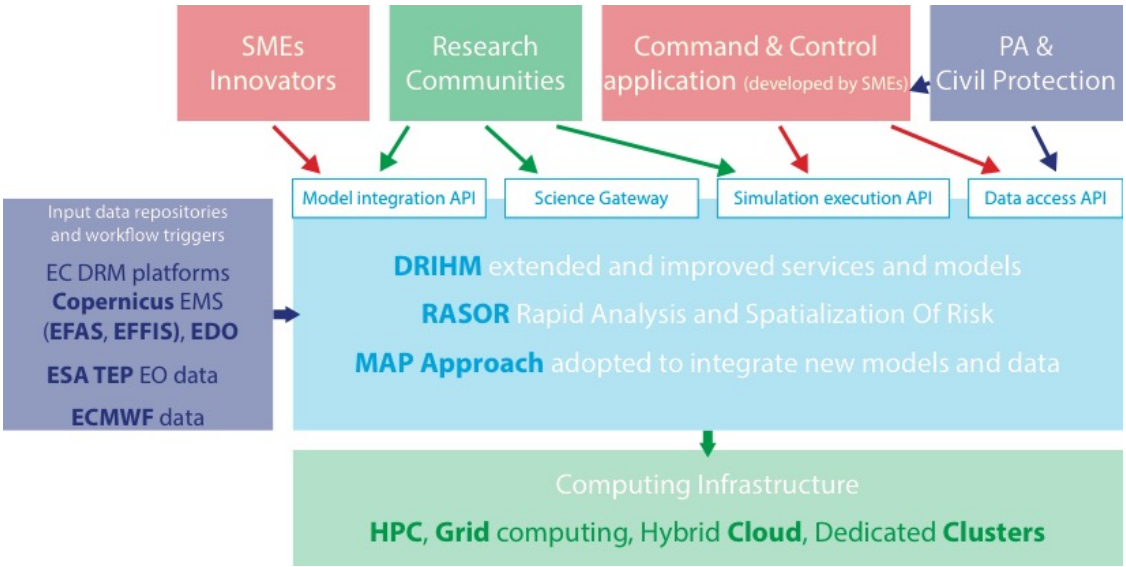


Figure 1: HYEEA ecosystem.

[5] https://www.efas.eu/
[6] forest.jrc.ec.europa.eu/effis/
[7] http://edo.jrc.ec.europa.eu
[8] http://www.drihm.eu
[9] https://hydrology-tep.eo.esa.int/
[10] https://geohazards-tep.eo.esa.int/#!
[11] http://www.rasor-project.eu/

Objective 3: standardisation leading to economies of scale that facilitate access to and uptake of DRM resources and facilite new inter- and transdisciplinary collaborations between adjacent, but not connected, scientific communities

Using standardized building blocks, HYEEA will provide its DRM services masking the underlying complexities that specific service implementations require from non-ICT experts. These building blocks will make collaboration between adjecent, but not always connected, (Hydrology, Meteorology, Hydraulics, Climatology, Remote Sensing, and Information and Communication Technologies) user communities easier and will encourage deeper alignment of the working practices in the different targeted fields. Bringing these – so far separated – user communities together will also make investments in the tools usability more feasible, eventually allowing solutions that will be able to serve audiences ranging from researchers to general public. The HYEEA functional framework is built around a set of components, which can be interfaced to databases or web services, numerical models or other supporting tools for analysis and visualisation. The full set of these components is represented by an ontology describing the relationships and valid interfaces between them. This is set out in terms of the scientific phenomena and the data structures used to describe them (both spatially and temporally). For numerical models and data-model interfaces, these components come together in the high level "M.A.P." methodology, as devised and utilised for the DRIHM project (Harpham and Danovaro[12] 2014). For each numerical model component, a M.A.P must be provided as follows: **M – Metadata, Documentation and Licence**: Each model component must be supplied with metadata according to a given standard, appropriate documentation and a licence for users to use it; **A – Adaptors (or Bridges)** must be provided, which translate the model inputs and outputs from and to common standards; **P – Portability.** Each model must be made portable, that is, not tied strongly to local infrastructure and able to run on any technically similar system.

These three objectives:

- **Are clearly addressing the call expectations**: support capacity building of interdisciplinary scientific and operational communities (Hydrology, Meteorology, Hydraulics, Climatology, Remote Sensing, Geology, and Information and Communication Technologies) and provide services and tools enabling DRM activities. HYEAA will be continuously driven by user needs, both on the scientific and operational sides. By continually enriching, improving and extending its services, it will meet new and evolving user needs as well as scientific and technological development as they arise;
- **Are measurable: the objectives** are linked with established scientific and operational practices of the communities they serve. This will allow the benchmarking of the innovative services developed in the context of an existing (and growing) set of use cases. By making the services available for all profit-making users (e.g. SMEs and innovators), public admininistration users and research users on the study of natural hazards active in this field the consortium can directly gather data and knowledge that allows assessment of the end-user experience of the services;
- **Are considered realistic and achievable:** HYEAA is built on well-consolidated services and tools, such as pre-existing Earth Science oriented e-Infrastructures, model and data interoperability solutions and extensive experiences from earlier research, development and operational deployment activities that the consortium brings together. **It focuses on the needs of profit-making users (e.g. SMEs and innovators), public admininistration users and research users on the study of natural hazards from the event scale (up to 15 days in advance) to the seasonal scales (up to 7 months in advance) making these goals even more concrete and achievable**;
- **Are sustainable:** the objectives are consistently linked with the high-level strategic vision(s) in terms of the prediction and study of natural hazards provided by leading international

[12] Harpham, Q., and Danovaro, E. (2014). Towards standard metadata to support models and interfaces in a hydro-meteorological model chain.

strategies such as the EU societal challenges[13] and EU strategy on adaptation to climate change[14] . The work is also guided by a project consortium involving actors both from academia and industry, which makes possible to assess the market and innovation potential of the new tools and approaches for its sustainability beyond the life time of the project.

To achieve the project objectives, the HYEEA services will be based on:

Thematic e-Infrastructures

DRIHM results for the execution of complex hydro-meteorological dynamical and statistical downscaling workflows; ESA-TEP Hydrology and Geohazards focusing on the capitalization of Ground Segment capabilities and ICT technologies to maximize the exploitation of EO data from past and future missions for hydrological and geohazards, respectively, processes modeling and observation; on RASOR results to evaluate socio-economic impacts of a possible hazard simulated by HYEEA e-Infrastructure over a given target area; services by already TRL8 (or higher) existing EC DRM e-Infrastructures, such as EFAS, EFFIS, and EDO.

Global horizontal e-Infrastructures

Access to high-performance computing (supercomputing, PRACE) and high-throughput computing (HTC including grid computing, EGI, and cloud computing, HELIX-NEBULA); access to high end storage for ever increasingly large data sets (EUDAT); access to advanced networking services to connect computing and storage resources to users and instruments (GÉANT); middleware components to enable the seamless use of the above services, including authentication and authorisation.

Generic services for DRM, providing support for research and operational workflows using combinations of the above

Services for the development of the HYEEA scientific gateway solution[15] for actual execution of workflow steps and data movement; well-codified Open Geospatial Consortium (OGC) encoding and interface standards, such as netCDF combined with CF (Climate & Forecasting) conventions for gridded data type, WaterML 2.0 for encoding time series, OpenMI for in memory model interfacing; Application Programming Interfaces (APIs) (e.g. ECMWF- European Centre For Medium-Range Weather Forecasts GEOWOW) to benefit from enhanced discoverability, accessibility and exploitability of hydro-meteorological data and other DRM-related data.

1.2 Relation to the work programme

Workprogramme: "There is a need to support user-driven design and prototyping of innovative e-infrastructure services and applications to meet the needs of those communities that push the envelope in scientific and technological domains requiring top-of-the range capacity in the long term."

A key on-going goal for DRM is to close the gap between available scientific analysis supporting prevention, preparedness and response measures, and the effective use of scientific information to trigger such actions. As natural hazards become more frequent and severe, increasing the resilience to crises and disasters requires the continued development of innovative technologies, tools and methods to manage disaster risk and emergencies, such as risk assessments and early warning systems.

Them, DRM is one of the interdisciplinary areas, where new ways of dealing with increasingly complex problems could be made possible by e-Infrastructure services, but where these services have often been only partially adopted by end users due to a lack of common practices and missing tools and "enabling" components.

To achieve its objectives, **HYEEA will provide an innovative, service-based, e-Infrastructure exploiting the best existing research and operational DRM e-Infrastructures, such as EFAS,**

[13] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges

[14] http://ec.europa.eu/clima/publications/docs/eu_strategy_en.pdf

[15] D'Agostino D. et al. (2015). Lessons learned implementing a science gateway for hydro-meteorological research. Concurrency and Computation Practice and Experince DOI: 10.1002/cpe.3700

EFFIS, EDO, DRIHM, ESA TEP, and RASOR, building on top of global e-Infrastructures (PRACE, EGI, EUDAT, HELIX-NEBULA, and GÉANT)
Such HYEEA e-Infrastructure will leverage an extensible set of components (i.e. state-of-the-art model engines), running on Grid, Cloud and high performance computing (HPC) resources and orchestrated as a micro-service infrastructure with fully standardized interfaces, based on OGC standards: here the DRIHM M.A.P. approach[16] will form a gateway concept consisting of a checklist of elements which must be in place before a numerical model is offered for interoperability in a structured environment and at a level of abstraction suitable to support environmental model interoperability in general. Like in ESA TEP this computing platform follows a given set of scenarios for users, data and ICT provision.
A strong Evaluation and Quality Control (EQC) system responsible for mapping evolving user needs into viable service requirements will be implemented within the HYEEA support centre (WP6) to ensure to the success and sustainability of the project services and tools. The EQC system must ensure that this project will represent the state of the art in the study and prediction and study of natural hazards from their onset to the subsequent social/economic/environmental impacts and that innovative service developments are introduced that reflect current research, operational and business opportunites of interest for DRM activities.
Workprogramme: "It is also important to promote multi-domain community-driven approaches to fully exploit core e-infrastructure services with high economic innovation potential. With the support of, for example, independent software vendors, engineering companies, innovation clusters and Research and technology organisations, e-infrastructures should open up to innovative stakeholders, including researchers, citizens and SMEs, to exploit a wide range of technology developments, research results and data".
When speaking about fully exploiting core e-infrastructure services for DRM targeting high economic innovation potential, a number of stakeholders emerge: **research organizations** want the access to the best research facilities and instruments to gain a deeper understanding of natural hazards and improve the predictive ability targeting operational activities; **global e-Infrastructures operators** want to deliver the best services to respond to needs of research and operational institutions of integrate state-of-the-art technology in the mainstream infrastructure, explore innovative technologies for the long-term needs and sustainability for improving DRM activities; **industry** wants to be competitive, especially through the involvement of SMEs, by leveraging on new knowledge and know-how, developing and testing new products such as innovative data and models; **funders** want to support scientific discovery and innovation sustainable investments, promoting excellence and inclusiveness; **citizens** are willing to be more aware about the DRM activities, also in terms of use of money provided by funders for the production of better and faster results improving DRM activities and thus representing a return on investment/benefit for the society.
The project consortium is certainly well-positioned to engage aforementioned stakeholders: **CIMA, ECMWF, BSC, TERRA2, LMU and IMATI (Institute for Applied Mathematics and Information Technologies)-CNR will ensure and enable a constant dialogue with the Earth Science and ICT research organizations dealing with DRM for natural hazards**; again **ECMWF, BSC, TERRA2, and LMU, because of their experience in managing state-of-the-art computing and data services, are in a perfect position to deliver services to research and operational entities dealing with DRM**; **TERRA2 and ALTAMIRA will prompt a constant dialogue with innovation clusters to enable the usage and upgrade of the project services from different SMEs** active on the ICT and Earth Science sides of DRM, from the prediction sides down to the natural hazards societal and economical impacts. **As value-added, ALTAMIRA will conduct service trials based on their commercial landslides and flood mapping services in combination with the forecast service proposed by HYEAA, in order to demonstrate the enhanced capacity for innovation in production and for the generation of new commercial services enabled by the proposed solution.**

[16] Harpham, Q. et al. (2015). Using a Model MAP to prepare hydro-meteorological models for generic use. Environmental Modelling & Software, 73, 260-271.

Reference actors for the networking activities with the innovation clusters will be the **European Cluster Observatory (ECO[17])** and the **European Institute of Innovation & Technology (EIT[18], *see the OASIS+[19] Consortium support letter as part of EIT-CLIMATE KIC*), both part of the forthcoming HYEEA International Advisory Board.**

ECO is a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe that is aimed at European, national, regional and local policy-makers as well as cluster managers and representatives of SME intermediaries. It aims to promote the development of more world-class clusters in Europe, with a view to fostering competitiveness and entrepreneurship in emerging industries and facilitating SMEs' access to clusters and internationalisation activities through clusters.

EIT is an independent EU Body set up in 2008 to enhance Europe's ability to innovate by nurturing entrepreneurial talent and supporting new ideas, through its Knowledge and Innovation Communities (KICs). Among the existing KICs, the EIT Digital (addressing information and Communication Technologies) and the Climate-KIC (addressing climate change mitigation and adaptation) are of primary interest for the HYEEA networking and user engagement activities.

Workprogramme: "Opening e-infrastructures to develop and test innovative functionalities and advanced technology entails the support to Open Science and stairways for excellence to increase citizen's trust in science, bridging the gap between the leading research and education communities and the wider population."

Open Science pertains **Open Access** (freely available results) and **Open Data** (access to the underlying data), but also **Open Research**, as the sharing of research methods and software[20]. Open Science is seen as a huge step forward in making research results more reproducible, gaining transparency, and easing collaboration on existing research data both from research users, but also from profit making users (SMEs) and PAs. Even if the major challenge for Open Science is the change in scientific culture, e Infrastructures, both global ones and thematic ones, are fundamental instruments for Open Science.

The HYEEA services will adhere and support as much as possible to Open Science principles[21], then: data and models will be discoverable by means of a standard identification mechanism (DOI); accessible with licenses (ranging from licencing framework for research and education to commercial exploitation); assessable, and intelligible; useable beyond the original purpose for which it was collected in order to maximize their impacts and also their economical potential; interoperable to specific quality standards allowing exchange between researchers, institutions, organisations, and different stakeholders. Furthermore, **HYEEA will enable the Open Science vision through the provision of services for: open research data, data and computing intensive science, high performance, grid, and cloud computing services, and big data innovation.**

To ensure growth and continuous access to its services, HYEEA will complement traditional dissemination organisational structure with a "community manager" focusing on cultivating relationship with the different project stakeholders, namely research and operational institutions, industry/SMEs, funders, and citizens (task WP6.4). The community manager is responsible for gathering information about factors that motivate different stakeholders, and for developing models that allow project to increase its socio-economic capital with the contributor groups. The community manager will e.g. ensure that dissemination material credits the different stakeholders. Community manager can also consider "human interest" approaches, e.g. including personal profiles and interviews of different stakeholders in the project dissemination material.

[17] http://ec.europa.eu/growth/smes/cluster/observatory/about/index_en.htm
[18] http://eit.europa.eu
[19] http://www.plateformesolutionsclimat.org/wp-content/uploads/2015/07/Oasis-business-plan-Executive-summary.pdf
[20] http://e-irg.eu/documents/10920/11274/e-irg-white-paper-2013-final.pdf
[21] https://www.gov.uk/government/news/g8-science-ministers-statement

1.3 Concept and approach

Increasing vulnerability and exposure of people and assets and greater frequency and severity of disasters resulting from natural hazards, combined with the related increased complexity of managing emergencies and risks, require innovative ways to carry out crisis management policies and operations. Making better use of existing knowledge at all stages of the DRM cycle – from prevention, reduction and preparedness to response and recovery – and at all levels – local, national, European and global – is therefore a priority both in policy-making and operations related to natural hazards.

This concept is gaining gradually more consensus at the European level, where the new Union Civil Protection Mechanism (UCPM) legislation[22] addresses all aspects of the DRM cycle by strengthening cooperation and facilitating coordination within Europe in the areas of disaster prevention, preparedness and response. Among its priorities is the action to "improve the knowledge base on disaster risks and facilitate the sharing of knowledge, best practices and information"[23], **also through The Emergency Response Coordination Centre (ERCC[24]) enabling the EU and its Member States to respond to overwhelming natural and man-made disasters in a timely and efficient manner**.

EU Council conclusions[25] on risk management capability invites the Commission to take actions to encourage Member States to develop systems, models or methologies for collecting and exchanging data on ways to assess the economic impact of disasters in an all-hazards approach. The need to improve the use of scientific and operational knowledge is now widely acknowledged in DRM at all levels, including: scientific resources, data, various sources of operational knowledge (e.g. early warning and response activities, as well as humanitarian actions), including lessons learnt, results of local, national and regional DRM-related projects and existing cooperation programmes and projects with third countries, as well as developments in innovation (e.g. technological and social innovation). To improve all stages of the DRM cycle, the knowledge and evidence base needs to be further improved, advances in relevant technology exploited, research results applied, and the interaction between researchers and end users enhanced. At the European level, many scientific centres have developed a capacity to analyse, evaluate and warn their respective national authorities about forthcoming natural hazards in order to prevent damage and casualties but also to prepare and warn communities in advance of a disaster: **however, this effort towards scientific results that are 'useful, usable and used' should be further strengthened**.

HYEEA project intends to be a contribution to the EU strategy in the DRM domain by launching ICT pilot (TRL8) services: HYEEA will support user-driven design and prototyping of innovative DRM e-infrastructure services (sections 1.3.1, 1.3.1.1, 1.3.1.2 and 1.3.2) for natural hazards probabilistic multi-model/multi-data prediction and prevention by pushing the scientific and technological envelope in this field, through the integration of the services offered by existing research and operational e-Infrastructures and services, such as EFAS, EFFIS, EDO, DRIHM, ESA TEP, and RASOR (Figure 2), on top of global e-Infrastructures services. HYEEA natural hazard temporal scales focus will be twofold**:**

- On the event scale (up to 15 days ahead): saving lives and reducing societal impact of individual natural hazards events, in agreement with the EU strategy for fighting and adapting to climate change[26]. Despite very relevant efforts and substantial progress in predictive ability and emergency management activities, the last few years have continued to see a large number of natural disasters with a significant death toll and displacing a large amount of people, which were responsible for widespread socio-economic impacts;

[22] Council Decision No. 1313/2013/EU, *Official Journal of the European Union,* L347, 20.12.2013
[23] Art.5.1(a), Council Decision No. 1313/2013/EU, *Official Journal of the European Union,* L347, 20.12.2013
[24] http://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/ERC_en.pdf
[25] Council of the EU Conclusion on risk management capability 13375/14
[26] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/fighting-and-adapting-climate-change-1

- On the seasonal timescale (up to 7 months ahead): improving overall societal resilience foundations of security, in agreement with the EU strategy for bioeconomy[27]. There is the unique opportunity to capitalise the shorter-scale expertise and climate research communities, to improve predictions on a timescale of particular societal and economical relevance. The seasonal range is particularly important as many management decisions in disaster risk reduction, agriculture and food security, water, and health fall into this range (Brunet et al.,[28] 2010 and Doblas-Reyes et al.,[29] 2013). The following subsections describe first the overall concepts behind the project approach (with reference to **Figure 2**), and the envisioned technical functionalities before outlining the project methodology. A gender analysis closes this section.

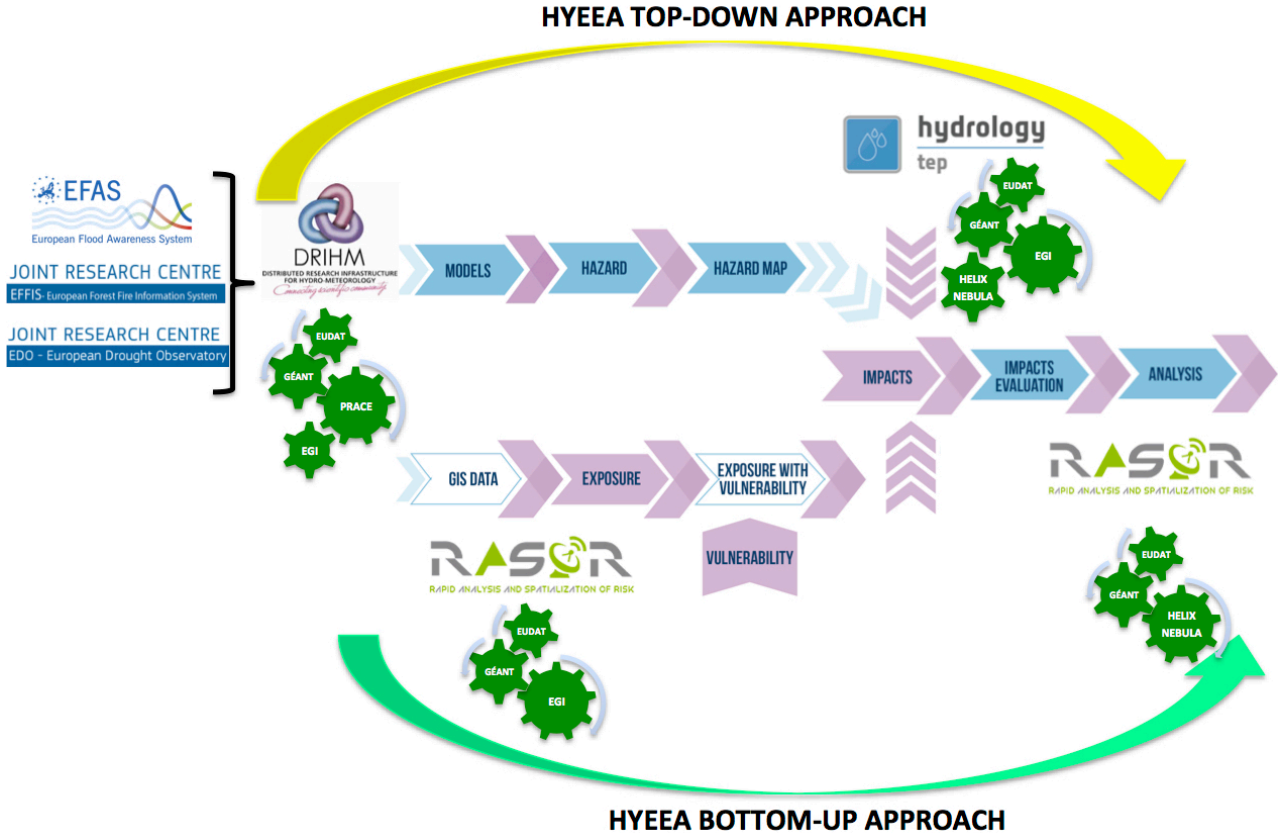


Figure 2: HYEEA rational, including involved DRM research and operational e-Infrastructures, on top of enabling global e-Infrastructures.

1.3.1 Overall concepts underpinning this project

Because natural hazards are rare events by definition, a single deterministic simulation is not likely to capture them and does not allow the evaluation of their probability of occurrence from the event scale to the seasonal scales. The most suitable approach to tackle this issue is represented by probabilistic modelling chains, in which large ensembles of initial conditions and/or multiple models allow multiple possible realizations of the same floods and flash-floods event to be produced, and then to evaluate both the modelling uncertainty and the internal variability of the climate system. Such result is not easily achievable. Many attempts have been made in many countries to build up a sound natural hazards probabilistic prediction chain, but in most cases they use a few set of models, often linked with handcrafted scripts. The DRIHM project

[27] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/bioeconomy
[28] Brunet, G., Shapiro, M., Hoskins, B., Moncrieff, M., Dole, R., Kiladis, G. N., and Shukla, J. (2010). Collaboration of the weather and climate communities to advance subseasonal-to-seasonal prediction. *Bulletin of the American Meteorological Society*, *91*(10), 1397-1406.
[29] Doblas-Reyes F.J., García-Serrano J., Liener., Biescas A.P., and Rodrigues L.R. (2013). Seasonal climate predictability and forecasting: status andprospects. Wiley Interdisciplinary Reviews: Climate Change 4: 245–268. 2, 3, 11, 12, 15

outcomes represent a first step in this direction (D'Agostino et al.[30] 2014; Danovaro et al.[31] 2014), but the goal of such project were mainly limited to the execution of deterministic chains for single event(s). Therefore today there is not a system able to provide these functionalities in a fully probabilistic multi-model and multi-data ensemble prediction framework, which requires the development of a set of innovative services to retrieve and store the data, to select and access proper computational infrastructures and for the coordinated management of multi-model ensemble simulation executions.

HYEEA will provide its DRM computing and data intensive services, based on two complementary approaches (with reference to Figure 2):

- The **"top-down" approach** begins from natural hazards scenarios, recognizing climate change as a source of risk and proceeds through weather downscaling and impact assessment sequence toward gauging vulnerability in climate-affected sectors of society. This approach is conceptually appealing as it mimics the main process cascade and is based on a scientific system understanding, but the downside is that it may not adequately recognize the context of local conditions and stressors that equally or more strongly affect those sectors;
- The **"bottom-up" approach** starts from the resilience of the communities in question and explores the key system sensitivities with a stress-testing method. In highly vulnerable settings, it is particularly important to perform bottom-up risk analyses, that is, to start from policy options and their risks, and local information, rather than to perform top-down modeling alone.

The HYEEA top-down approach integrates hydro-meteorological predictions and observations in a seamless way from the event to the seasonal temporal scales, building on the existing research and operational e-Infrastructures and services, such as EFAS, EFFIS, EDO, DRIHM, and ESA-TEP hydrology. **The HYEEA workflows will be executed according to two different configurations, depending on the temporal and spatial scales under consideration, mapping the cartoon presented in** Figure 3**:**

- **Event scale prediction**: from weather probabilistic products at the global scale through multi-model limited area cloud permitting (grid spacing O(5-1 km) meteorological ensembles, executed mainly on HPC resources, namely PRACE) runs to different possible natural hazards modelling areas (hydrologic and hydraulic modelling, wildfire modelling, and drought modelling, executed mainly on grid and cloud computing resources, namely EGI and HELIX-NEBULA);
- **Seasonal prediction**: from seasonal forecast systems at the global scale through statistical downscaling ensembles to different possible natural hazards modelling areas (hydrologic and hydraulic modelling, wildfire modelling, and water resources/water quality modelling, executed mainly on grid and cloud computing resources, namely EGI and HELIX-NEBULA).

[30] D. D'Agostino et al., The DRIHM Project: A Flexible Approach to Integrate HPC, Grid and Cloud Resources for Hydro-Meteorological Research, Proceedings of the International Conference For High Performance Computing, Networking, Storage and Analysis (SC14), pp. 536-546, 2014.

[31] Danovaro, E., Roverelli, L., Zereik, G., Galizia, A., D'Agostino, D., Paschina, G., ... & Richard, E. (2014). Setting Up an Hydro-Meteo Experiment in Minutes: The DRIHM e-Infrastructure for HM Research. In e-Science (e-Science), 2014 IEEE 10th International Conference on (Vol. 1, pp. 47-54). IEEE.

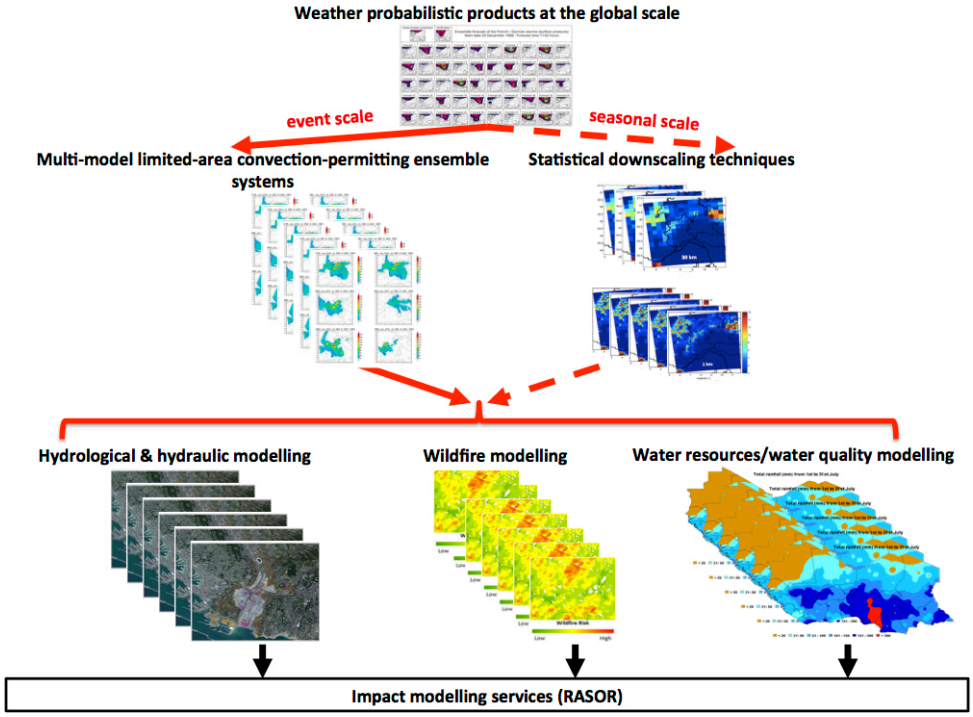


Figure 3: HYEEA top-down approach for the event scale (red line) and seasonal scale predictions (red-dashed line).

The HYEEA bottom-up approach uses exposure and vulnerability information, provided by RASOR, to analyze the socio-economic impacts of natural hazards, through the outputs of the HYEEA predictive workflows and the HYEEA observational dataset.

As an example[32], December 2015 saw Storms Desmond, Eva and Frank cyclones hit the United Kindgom producing natural hazards such flood, flash-floods and landslides, breaking meteorological records and causing a very high financial pressure on the insurance industry generating an intense debate over the impact and role of climate variability, flood defense infrastructure and the applicability of earnings protections in the insurance industry: Willis RE estimated that the 2015 average claim size was among the highest in the last 25 years in UK, partly explained by the extremely localized nature of the events, and their flash-flood nature (meaning that alerting the public and mitigating claims is then more difficult). **Investigating natural hazards often bring the question of whether events, such as those of December 2015 in UK, will become more frequent in the future as well as whether climate change is a contributing factor to localised rainfall extremes: in this respect, HYEEA bottom-up approach and related services can result of great relevance, also for the insurance and reinsurance sector (*see the OASIS+[33] Consortium support letter as part of EIT-CLIMATE KIC)*.** Along these lines, RASOR services allow dividing up the elements of catastrophe loss modelling into plug and play component as in Figure 4. RASOR is a calculator that can be communicated with web services, on top of EGI and HELIX NEBULA. The central part, shown in black, is termed the kernel as it sits agnostically behind plug and play connectors or sockets that relate the external actualized model and business data to the abstract structures used for the calculations. The technical architecture of RASOR services addresses three key criteria:

- **Extensible** – being able to cope with a very wide variety of models and business users within the paradigm of event-based loss modelling. It achieves this through the agnostic kernel, variable definition tables, and connectors which are pieces of code that transform data into the RASOR agnostic format;

[32] http://blog.willis.com/2016/03/the-uk-floods-record-breaking-december-how-bad-was-it/
[33] http://www.plateformesolutionsclimat.org/wp-content/uploads/2015/07/Oasis-business-plan-Executive-summary.pdf

- **Scalable** – being able to run with a wide range of data sizes, from small coarse-grained models for a few properties up to high-resolution models with hundred of thousands of events for millions of properties;
- **Deployable** – the software can be readily run in a variety of environments, and second, that it fits into the technology estates of the main users as far as possible. The first aim is achieved by means of an open-source set of components (Linux, Apache, MySQL, and Python). The second aim is achieved by adopting virtual machine solutions, which are deployable on a wide variety of platforms as well as native linux.

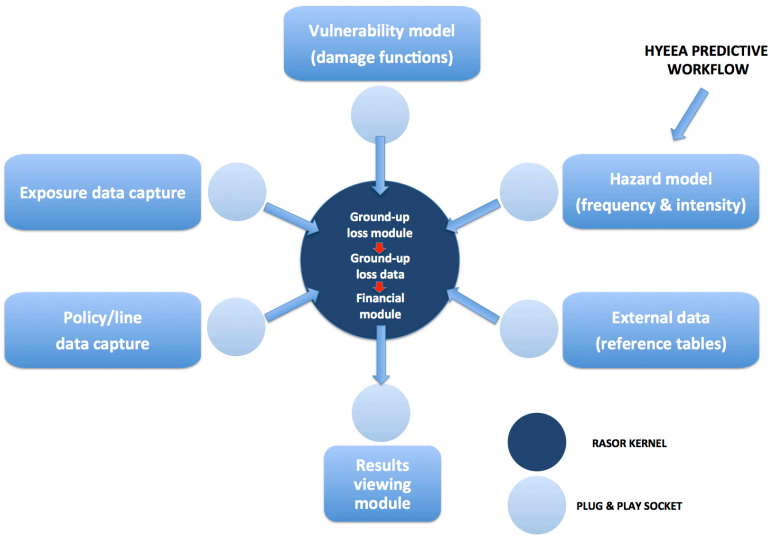


Figure 4: The HYEEA bottom-up approach for impact modelling framework.

The project services will be interoperable with European early warning, detection and alerting systems for natural hazards prediction and prevention (in particular EFAS, EFFIS, and EDO) targeting fine spatio-temporal resolutions for natural hazards DRM activities, with two different modelling usecases: at the event and seasonal scale (section 1.3.1.1 and section 1.3.1.2).

1.3.1.1 Event scale modeling use cases

The event scale modelling is the foundation for efficient disaster response and management, thus activites in this domain address specific requirements of much broader set of European initiatives supporting secure societies than the one explicitly mentioned in the proposal.
The event scale modeling use cases (UC) are depicted in Figure 5 showing the key ingredients, namely:

- Meteorological input data provided by ECMWF meteorological data sources (high resolution and ensemble mode, section 1.3.1.3) and/or customized access to alternative data sources, such as Global Forecasting System (GFS);
- A set of meteorological model engines (WRF-ARW, NMMB-BSC, and COSMO, section 1.3.1.4) to be operated down to cloud permitting grid spacing O(5-1 km);
- A set of hydrological model engines (DRiFt, RIBS, and Continuum, section 1.3.1.4) available on selected european catchments, and inherited from the foreground of the DRIHM project;
- Observational data in terms of ESA TEP Hydrology, EFAS Hydrological and Meteorological data, and national meteorological observational dataset to further enrich EFAS datasets (section 1.3.1.3).

The following typical use cases for event scale modeling scenario can be formulated:

1. ***UC1 – new hydro model event scale: Addition of a new hydrological model engine over the platform***. Let suppose that a regional environmental agency (public end user) dealing with DRM is interested in executing its own hydrological model over a given catchment of interest, exploiting the computing resources provided by the platform and not available in house. One of the key prerequisites in executing such class of models is the model calibration over the targeted catchment. Two situations then may occur:

a. The hydrological model is already calibrated, then the aforementioned regional environmental agency needs *only* to plug the model instance on the platform, using the DRIHM M.A.P approach, to exploit its computing and data storage services;
b. The hydrological model is uncalibrated, then the aforementioned environmental agency needs, *first*, to perform the model calibration off the platform, and, *secondly*, to plug the corresponding model instance on the platform to exploit its computing and data storage services.

Both UC1-a and UC1-b can create significant market and business opportunity for hydraulic engineering companies and/or SMEs belonging to environmental clusters to perform the technological steps enabling the execution of the models over the chain.

2. ***UC2 – EFFAS alert: An EFAS flash-flood alert is issued over a given catchment***, and a platform end user (Civil Protection agency, environmental agency, and so forth) is interested in predicting the peak discharge for a catchment where an hydrological model engines is already available (DRiFt, RIBS, and Continuum, section 1.3.1.4) or it has been deployed as part of US1. Thus the user will execute the following workflow using the HYEEA services provided by the platform and not available in house: Select the input meteorological data (deterministic ECMWF IFS+probabilistic ECMWF ENS), select the cloud resolving meteorological model (out of WRF, NMMB-BSC, and COSMO) to be operated at cloud resolving grid spacing O(5-1 km) *on HPC resources as the ones available in PRACE or in EGI*, with innermost domain of maximum extent 1000x1000 km^2, select the hydrological model engine available on the target catchment, *to be executed on EGI resources*.

3. ***UC3 – FIRE risk: An EFFIS daily fire danger forecast corresponding to very high or extreme danger is issued over a given area***, and a platform end user of the (Civil Protection agency, environmental agency, and so forth) is interested in predicting the Fire Weather Index (FWI) and/or Combined Drought Indicator (CDI) at finer spatio-temporal resolution over a given area. Thus the user will execute the following workflow using the HYEEA services: select the input meteorological data (high resolution ECMWF IFS+probabilistic ECMWF ENS), select the cloud resolving meteorological model (out of WRF, NMMB-BSC, and COSMO) to be operated at cloud permitting grid spacing O(5-1 km) *on HPC resources as the ones available in PRACE or in EGI*, with innermost domain of maximum extent 1000x1000 km^2, select the RISICO model, or FWI or CDI modules on the target area, *to be executed on EGI resources.*

4. ***UC4 – Impact analysis (RASOR): Assessing risk is a necessary first step to reducing the exposure of populations and assets to risk and it requires the analysis of three separate elements: exposure, hazards and vulnerability.*** Documenting them, and understanding how they evolve and interact, are critical to reducing risk. The RASOR project developed a set of services to perform multi-hazard risk analysis to support the full cycle of disaster management, including targeted support to critical infrastructure monitoring and climate change impact assessment. The HYEEA modelling outputs for use stories 2, 3 and 4 will represent an input for the RASOR workflows, *to to be executed on EGI and HELIX-NEBULA resources*.

5. ***UC5 – Innovative actors should be able to incorporate HYEEA information into their services in order to enhance the production of added-value services resulting in commercial revenues***. To demonstrate this, the EO-based ground motion service prototype available at the TEP Geohazards, and the EO-based flood map service demonstrator available at the TEP Hydrology, both uploaded by Altamira Information, will integrate event scale forecasts and possibly seasonal forecasts, with the objective of bridging to a mature qualification level to respond to the users needs on risk management activities.

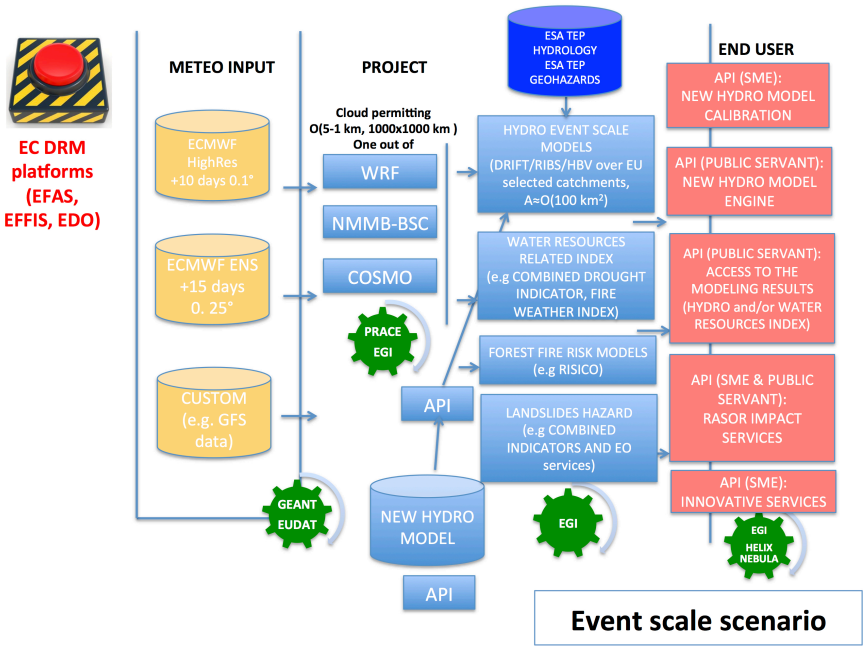


Figure 5: HYEEA event scale modeling use cases.

1.3.1.2 Seasonal scale modeling use cases

Seasonal scale modelling of natural hazards is important part of international projects, such as Sub-seasonal to Seasonal (S2S[34]) prediction project, to understand systematic errors and biases in the subseasonal to seasonal forecast range, and to evaluate potential predictability from subseasonal to seasonal events, including identifying windows of opportunity for increased forecast skill.

The seasonal scale modeling scenario is depicted in Figure 6 showing the key ingredients, namely:

- Seasonal forecast of a 51 member ensemble provided by ECMWF (ensemble mode, section 1.3.1.3);
- A set of statistical downscaling tools to be applied to seasonal natural hazards predictions;
- A set of hydrological model engines (DRiFt, RIBS, and Continuum, section 1.3.1.4) available on selected european catchments;
- Observational data in terms of ESA TEP Hydrology, EFAS Hydrological and Meteorological data, atmospheric reanalysis and national meteorological observational dataset to further enrich EFAS datasets.

The following typical use cases for event scale modeling scenario can be formulated:

1. ***UC6 – new hydro model seasonal scale: Addition of a new hydrological/water resources model engine over the platform***. Suppose that a regional environmental agency (public end user) dealing with DRM is interested in executing its own hydrological/water resources model over a given catchment of interest, exploiting the computing resources provided by the platform and not available in house. One of the key prerequisites in executing such class of models is the model calibration over the targeted catchment. Two situations then may occur:
   a. The hydrological/water resources model is already calibrated, then the aforementioned regional environmental agency needs *only* to plug the model instance on the platform to exploit its computing and data storage services;
   b. The hydrological/water resources model is uncalibrated, then the aforementioned environmental agency needs, *first*, to perform the model calibration off the platform, and, *secondly*, to plug the corresponding model instance on the platform to exploit its computing and data storage services.

[34] http://s2sprediction.net/

Both US6-a and US6-b can create significant market and business opportunity for hydraulic engineering companies and/or SMEs belonging to environmental clusters to perform the technological steps enabling the execution of the models over the chain. Furthermore SME active in the environmental services sector can be also interested in using these data for agriculture related applications and so forth.

2. ***UC7 – new water resources seasonal scale assessment: Water managers have to design the strategy for the forthcoming months to distribute water resources between agriculture use, human consumption (residential, commercial and industrial) and maintenance of the river's ecological flow***. To estimate future precipitation over coming months and seasons is crucial to manage water reservoirs. Current practices are based on retrospective climatology, with an assumption that the past will also represent the future. We can apply seasonal forecast simulations to predict the variability of precipitation to provide useful information for water management activities. Then an end user of the HYEEA services (for example a regional environmental agency – *see ARPAL (Agenzia Regionale Per La Protezione Dell'ambiente Ligure) support letter*) will be able to use the project services by selecting the seasonal forecast option and apply statistical downscaling methods to obtain local information and finally select the hydrological/water resources model of interest among those available for the catchment under consideration *to be executed on EGI resources*, in order to obtain an ensemble of hydrological/water resources predictions, out of the different ensemble members.

3. ***UC8 – new water quality seasonal scale assessment:*** **Water managers have to deal not only with the amount of water resources but also with water quality.** Seasonal predictions can be used as input data for the hydrological model, which becomes especially relevant during periods of high precipitation, when the hydrogram is expected to experience the highest variation. Then water managers can use the hydrological model results to initialize a model of water quality. The idea is to focus in a particular problem affecting water quality, such as the effects of cyanobacteria algal blooms caused by heat waves, on drinking water quality.

4. ***UC9 – HYEEA simplified/pre-cooked workflows for citizen: HYEEA provides provide citizen (scientists) the possibility to run predefined workflows on a given set of data using a limited amount of computational resources.*** The advantage is that a citizen can select a seasonal forecast experiment and apply statistical downscaling methods at different locations to obtain local information. Furhtermore, if they are familiar with hydrological/water resources models they can initizalize hydrological/water resources models with seasonal forecast simulations to obtain an ensemble of hydrological/water resources predictions. Efficiently communicating a forecast means efficiently communicating the uncertainty associated with it. Therefore, citizens need to develop familiarity with the concept of forecast uncertainty in order to support their decision-making.

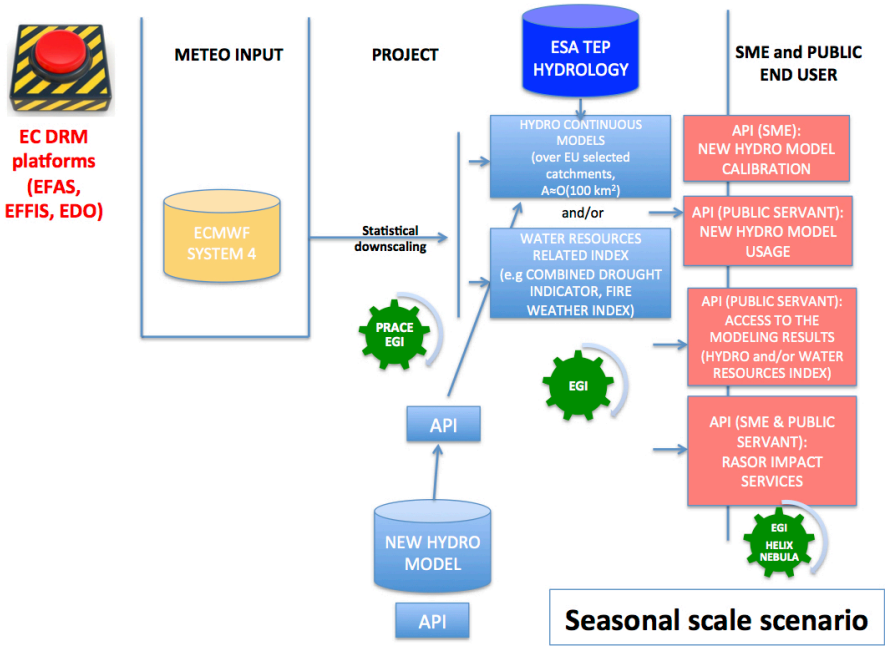


Figure 6: HYEEA seasonal scale modeling usecases.

1.3.1.3 The project observational and modeling datasets

HYEEA operates on and valorises datasets provided by ECMWF (meteorological simulations and seasonal forecast on a global scale), TIGGE (THORPEX Interactive Grand Global Ensemble) - LAM (meteorological data on a regional scale) and various observational sources.
ECMWF and TIGGE-LAM data are organized according to the following rationale.
Event scale prediction (up to 15 days): comprises the high-resolution and the ensemble forecasts of weather, at the space and time-scales represented by the relevant model, up to 10 and 15 days ahead, respectively, and the associated uncertainty.
At ECMWF, for the short and medium-range forecasts, an ensemble of 51 individual ensemble members (called ENS and providing a range of possible future weather states) and one high-resolution forecast (called HRES and providing a provides a highly detailed description of future weather) are created twice a day. HRES has, as initial state the most accurate estimate of the current conditions and it uses the currently best description of the model physics. As for ENS, one member (usually referred to as the control, CNTL and with a slightly lower level of average skill than the HRES) utilises the same initial conditions and model description as HRES, but is run at lower horizontal and vertical resolution.
The characteristics of these datasets can be summarised as follows:

	Forecast length	Number of members	Horizontal resolution	Perturbation models	IFS cycle
HRES	0-10 days	1	TCo1279/9 km	No	latest
ENS	0-15	51	TCo639/18 km	Yes	latest

In addition to ECMWF products, the TIGGE-LAM archive hosted at ECMWF (tigge.ecmwf.int/lam/) provides sets of ensemble forecasts by seven different limited area model ensembles, run at resolutions below 12 km, in either convection parameterised or convection-permitting mode, for forecast ranges up to five days ahead.
Seasonal scale prediction (the standard forecast length is 7 months): Seasonal Forecast System 4 comprises 51 members of forecasts up to 7 months ahead and the re-forecasts of 15 members from 1981 to 2010. This re-forecast is crucial to calibrate forecasts and to better assess their skill.
Seasonal forecasts occupy an intermediate zone between weather forecasting and climate projections. The extended-range forecast provides an overview of the forecast for the coming months and seasons.

Seasonal forecast share with the numerical weather prediction the difficulty of initializing the simulations with a realistic state of the atmosphere and the need to periodically verify different aspects of their quality, while additionally are burdened by uncertainties in feedback processes that also play a central role in constraining climate projections. Seasonal predictions have to deal also with the challenge of initializing all the components of the climate system (ocean, sea ice, and land surface). The value of skilful seasonal forecasts is obvious for many societal sectors such as water management and is currently being included in the framework of developing climate services. **This projects will also utilize seasonal scale predictions from the future System 5, which will be released in Q4/2016 as part of the Copernicus Climate Change Service.**

	Forecast length	**Number of members**	**Horizontal resolution**	**Perturbation models**	**IFS cycle**
Seasonal Forecast System 4	7 months	51 forecasts 15 reforecasts	T255/80 km	Yes	36r4

HYEEA observational databases for natural hazards will be made of different sources (raingauge, radar, satellite, hydrometer) provided by HYEEA partners and external services and it will cover the full range of scales from the event scale to the seasonal ones. Hereafter few examples:

- European high-resolution gridded daily data set (EFAS-Meteo) of precipitation, surface temperature (mean, minimum and maximum), wind speed, vapour pressure, calculated radiation and evapotranspiration (potential evapotranspiration, bare soil and open water evapotranspiration). The source data used to generate the EFAS-Meteo data set is collected and stored in two databases: The EU-FLOOD-GIS database is a data integration system for hydrological and meteorological data of various types and characteristics, e.g. time series and spatial data, which has been designed and developed as specific support to EFAS. Currently data from, circa 4000 meteorological stations and 750 hydrological stations are being collected; the JRC MARS database contains, amongst other data, daily meteorological data, which has been specifically designed and developed in support to agricultural applications, specifically the Crop Growth Monitoring System (CGMS). **Data from the JRC MARS and the EU-FLOOD-GIS database is extracted using the 2Map application, which has been developed in house. 2Map is written in Python following OOAD principles**;
- The HyMeX[35] (HYdrological cycle in the Mediterranean Experiment) database aims at documenting, storing and distributing the data (long-term observation periods – up to 10 years, enhanced observation period – up to 4 years, and special observation periods – some months), produced or used by the project community. It will manage past and recent geophysical in situ observations, satellite products, model outputs, and questionnaire data;
- E-OBS gridded version of the ECA dataset[36] (European Climate Assessment) with daily temperature, precipitation and pressure fields The ECA dataset contains series of daily observations at meteorological stations throughout Europe and the Mediterranean;
- The Alpine precipitation grid dataset (EURO4M-APGD[37]) extending over the entire Alpine region. The dataset is based on measurements at high-resolution rain-gauge networks, encompassing more than 8500 stations from Austria, Croatia, France, Germany, Italy, Slovenia and Switzerland;
- Basic hydrological information is available via the CCM2[38] (Catchment Characterisation and Modelling) project such as river basin, catchment and rivers. The CORINE[39] project, developed by the European Environment Agency (EEA), provides land use/land cover mapping for the EU over a number of years, the latest dataset. The EU-DEM Digital Surface Model[40], again

[35] http://mistrals.sedoo.fr/HyMeX/
[36] http://www.eea.europa.eu/data-and-maps/data/external/e-obs-gridded-dataset
[37] http://www.meteoswiss.admin.ch/web/en/services/data_portal/gridded_datasets/alpineprecip.html
[38] http://http://ccm.jrc.ec.europa.eu/php/index.php?action=view&id=24
[39] http:// www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-raster-1
[40] http://www.eea.europa.eu/data-and-maps/data/eu-dem

from EEA, is available at a resolution of 25 m. For surface and sub-surface properties two such datasets exist, the European soils databas[41], and One Geology Europe[42];

- Technological refinements of automatic weather stations foster the development of semi-professional Weather Networks (WN). These networks collect data observed by several personal weather stations, that may be operated by meteorological volunteers or included into citizen scientists institutional programs. Examples of such networks include Weather Underground[43], Weather Bug[44], Stations Météo[45] in France, and MeteoNetwork in Italy. Both the Weather Underground[46] and Weather Bug[47] supply APIs to recover actual weather condition as well historical weather series. Also MeteoNetwork provides APIs[48] accessing to the PWS data it manages since 2002, alternatively through Restful, SOAP or JSON-RPC.

1.3.1.4 The modelling engines

The following meteorological model engines, which are all used or piloted by the European initiatives supported by this project, will be deployed and shared over the platform in probabilistic configuration:

- The Weather Research and Forecasting (WRF) Model (www.wrf-model.org), originally developed at NCAR (National Center for Atmospheric Research), is a next-generation mesoscale numerical weather prediction system. The WRF model is operated in research mode (WRF-ARW) by CIMA and by BSC;
- COSMO (COnsortium for Small-scale Modelling) is a non-hydrostatic mesoscale atmospheric model developed in the framework of the COSMO Consortium (www.cosmo-model.org). The COSMO Model is operated in research mode by CIMA;
- The new unified Nonhydrostatic Multis cale Model on the Arakawa B grid (NMMB) has been under development at the National Centers for Environmental Prediction (NCEP) within the new NOAA (National Oceanic and Atmospheric Administration) Environmental Modeling System (NEMS) framework. The NMMB represents the second generation of nonhydrostatic models developed at NCEP. Except for being redesigned for the B grid, the model formulation follows the general modeling philosophy of its predecessor, the NCEP's regional Nonhydrostatic Mesoscale Model dynamic core in the Weather Research and Forecasting framework (WRF NMM). The NMMB can be run either globally or regionally with embedded nests. The NMMB/BSC model is operated in research and operational mode by BSC.

The following hydrological and hydraulic model engines will be shared and exported over the HYEEA platform, as part of the DRIHM services portofolio:

- DRiFt (Discharge River Forecast[49]) is a linear, semi-distributed model with constant parameters developed by CIMA;
- RIBS (Real-time Interactive Basin Simulator[50]) model developed by MIT and operated by UPM. RIBS is a topography-based, rainfall-runoff model, which can be used for real-time flood forecasting in midsize and large basins. Model use is especially attractive with distributed rainfall because the model maps the evolution of saturated areas over the basin as the storm progresses. RIBS can be run in deterministic or probabilistic mode;

41 http:// eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB/Index.htm
42 http://www.onegeology-europe.org/home
43 http://www.wunderground.com
44 http://weather.weatherbug.com/
45 http://www.station-meteo.com
46 http://www.wunderground.com/weather/api/
47 http://legacy.weather.weatherbug.com/pulseapi.html
48 http://www.meteonetwork.it/supporto/meteonetwork-api-eng/
49 dx.doi.org/10.1016/S1464-1909(00)00082-4
50 dx.doi.org/10.1016/0022-1694(94)02593-Z

- Continuum[51] is a continuous distributed hydrological model that strongly relies on a morphological approach, based on a novel way for the drainage network components identification. The Continuum model is operated in research and operational mode by CIMA

The RISICO[52] (Fire Risk and Coordination) wild fires risk assessment model, developed by CIMA, will be shared and exported over the HYEEA e-Infrastructure. RISICO is a system designed to support end users in the prevention of forest fires and it is fed from a continuous data stream consisting of real time weather observations, weather forecast provided by the available limited area models and satellite information. The system provides a quantitative assessment of the potential danger consequent to fire ignition in terms of rate of spread and linear intensity of the fire front.

1.3.2 System design

The HYEEA e-Infrastructure will be TRL 8 in nature, and it will provide a set of services for the study, evaluation, prediction of natural hazards and their social/economic/environmental impacts. The platform and the services it provides can be used as the base to implement new and specific services thus enabling the fast prototyping of innovative and multi-domain services from profit-making users (e.g. SMEs and innovators), public admininistration user and research users.
The HYEEA e-Infrastructure is based on the integration of the best existing global e-Infrastructures computing and data services (PRACE, EGI, HELIX NEBULA, EUDAT and GÉANT), on an extensible set of basic build blocks provided by existing operational and research thematic e-Infrastructures (i.e. EFAS, EFFIS, DRIHM, ESA-TEP Hydrology and Geohazards, and RASOR), and on state-of-the-art Web technologies. The exploitation of the services can be achieved through: a public platform instance (e.g. the DRIHM portal for research users and public administrations), a private production platform instance (e.g. private company business), and a cloud-based/customized instance (for a specific community or commercial services).
To shape this vision in an effective way, we schematized the platform has a set of loosely coupled components (Figure 7): **IS - Input Data Services, CS - Computing Services, Comp - Computational Infrastructure Services, OS - Output Data Services.** Such services can be combined and deployed in a **Platform Instance (PI)**, in order to provide a general purpose, commonly available instance, but also custom instances deployed on private premise. The available components fully support the **HYEEA UC - Use Cases** and can be exploited by innovators to support further Use Cases coming from the industry or the PAs.

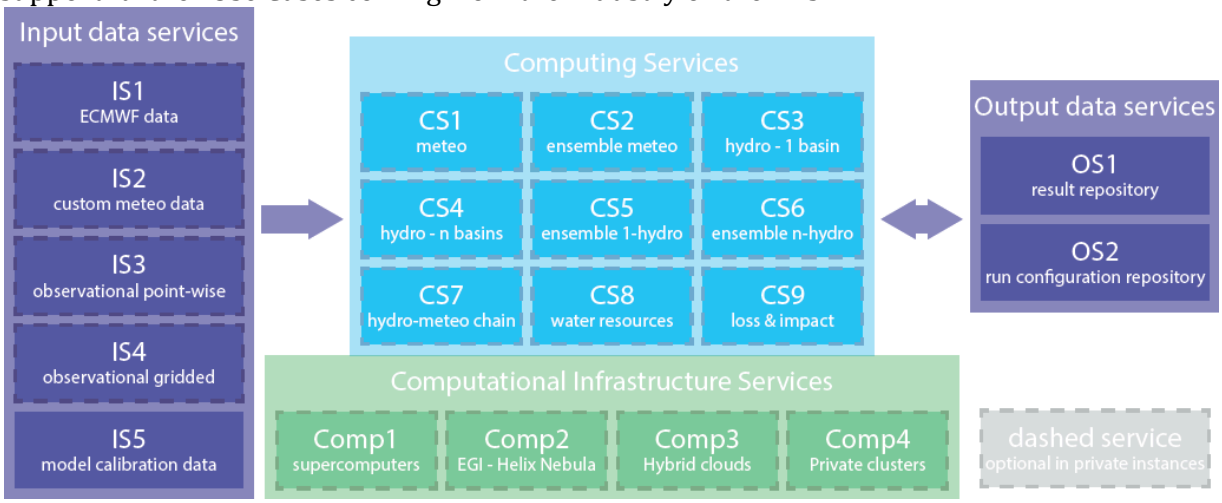


Figure 7: A platform instance exploiting HYEEA system and all its components. All services developed will be made discoverable on-line by including them in searchable catalogues. Private instances may include a subset of the services

[51] Silvestro, F., Gabellani, S., Delogu, F., Rudari, R., & Boni, G. (2013). Exploiting remote sensing land surface temperature in distributed hydrological modelling: the example of the Continuum model. Hydrology and Earth System Sciences, 17(1), 39-62.
[52] Mazzetti, P., Nativi, S., Angelini, V., Verlato, M., & Fiorucci, P. (2009). A Grid platform for the European Civil Protection e-Infrastructure: the Forest Fires use scenario. Earth science informatics, 2(1-2), 53-62.

Each instance of the platform can be built as a composition of the Hyeea services. Some of them are required (namely IS5, OS2 and OS3) while the others are pluggable during the instance configuration. Such modular structure and the flexibility to add further modules, paves the way to the development of higl-level services provided by innovators.

A public instance of the platform, managed by the consortium, exploiting all the HYEEA official modules will be made available. Such platform instance will provide services to the research community and a testing sandbox for the innovators.

1.3.2.1 IS - Input Data Service

The aim of the Input Data Services is to support the integration with the main European Data Providers for Meteorological and Hydrological communities. In particular, we consider:

- EFAS Meteorological and Hydrological data collection centre,
- ESA TEP Hydrology platform
- ECMWF datasets
- Regional hydro-meteorological data sources

Interfaces towards data providers will follow standard based approach, and in the project we may consider the design of specific interfaces in case of large data collection of interest when lacking standard interfaces.

Thus HYEEA provides the following services:

– ***IS1 ECMWF data access*** – this service allows to integrate present ECMWF services of interest within the platform;

– ***IS2 Custom data ingest*** – this service allows to ingest data from alternative global circulation models such as GFS (Global Forecasting System) and UK-MetOffice GCM;

– ***IS3 Observational point-wise data*** – this service allows to ingest data from EFAS Meteorological and Hydrological data collection centre, and regional hydro-meteorological data sources, such as HYMEX project;

– ***IS4 Observational gridded remote sensing data (ESA-TEP)*** – this service allows to ingest observational remote sensing data from the ESA-TEP Hydrology platform;

– ***IS5 HYEEA models instance repository*** – this service provides a repository of the new HYEEA models instances available on the platform, building on EUDAT services.

1.3.2.2 CS - Computing Services

The aim of the Computing Services is to enable the run of the state-of-the-art model engines for meteorological and hydrological communities. They will represent an extensible set of basic build blocks coupled adopting the aforementioned M.A.P. approach.

HYEEA will develop the following set of computing services:

– ***CS1 Deterministic single meteorological model run*** – this service allows the execution of a single meteorological model with a deterministic configuration, as required for the event scale scenarios;

– ***CS2 Ensemble single meteorological model run run*** – this service allows the execution of a single meteorological model with an ensemble configuration;

– ***CS3 Deterministic single hydrological model run on a single basin run*** – this service allows the execution of a single hydrological model on a specific basin with a deterministic configuration;

– ***CS4 Deterministic single hydrological model run on a region*** – this service allows the execution of a single hydrological model on a region, i.e. on an area that may contain more basins thus leading to a multi-basin run, with a deterministic configuration;

– ***CS5 Ensemble single hydrological model run on a single basin run*** – this service allows the execution of a single hydrological model on a specific basin with an ensemble configuration;

– ***CS6 Ensemble single hydrological model run on a region*** – this service allows the execution of a single hydrological model on a region, i.e. a multi-basin run, with an ensemble configuration;

- ***CS7 Full hydro-meteorological experiment chain*** – this service allows the composition of meteorological and hydrological models in a full chain through the state-of-the-art technology aimed at workflow definition;
- ***CS8 Water resources statistical downscaling run*** – this service allows the execution of seasonal statistical downscaling services, driven by the ECMWF S4 data, and providing an input for subsequent water resources and water quality applications;
- ***CS9 Loss and impact models run –*** this service allows the execution of RASOR exposure and vulnerability services to drive the RASOR impact modeling services, using input provided by the full hydro-meteorological experiment chain.

1.3.2.3 Comp - Computational Infrastructure Services

The aim of the Computational Infrastructure Services is to provide the possibility to run the CS - Computing Services on the best existing computing e-infrastructure such as supercomputers the Tier 0 and 1 of the PRACE project, resources from EGI, from cloud resources belonging to HELIX NEBULA cloud, and/or private clusters. These possibilities are mapped on the following services:

- ***Comp1 Execution on Supercomputers, mainly for CS1 and CS2 computing services***
- ***Comp2 Execution on EGI and HELIX NEBULA cloud, mainly for CS3-CS6 computing services***
- ***Comp3 Execution on hybrid clouds (e.g. OCCI, EC2 API…)***
- ***Comp4 Execution on private clusters (e.g. Slurm, PBS…), mainly for CS8-CS9 computing services***

More specifically HYEEA Computational Infrastructure Services services will target:

- ***PRACE*, providing HPC time to researchers in Europe on a set of 6 Tier-0 and Tier-1 systems of its partners provided by 4 Hosting Members (France, Germany, Italy and Spain).** PRACE systems are available to scientists and researchers from academia and industry from around the world through the process of submitting computing project proposals based on open R&D. Of particular interest for HYEEA, it is the SHAPE (SME HPC Adoption Programme) initiative a pan-European, PRACE-based programme supporting HPC adoption by SMEs. The Programme aims to raise awareness and equip European SMEs with the expertise necessary to take advantage of the innovation possibilities opened up by HPC, thus increasing their competitiveness;
- ***EGI*, providing four solutions to accelerate compute and data intensive research**. The *EGI Federated Cloud Solution* enables to deploy on-demand IT services via standards-based interface onto federate academic and commercial clouds from multiple provider. The EGI High Throughput Computing Solution enables to analyse large datasets, or to execute thousands of computational tasks. The *EGI Federated Operations Solution* provides technologies, processes and people required to manage the operations of a heterogeneous infrastructure and to integrate resources from multiple independent providers with a lightweight central coordination. The *Community-Driven Innovation & Support Solution* is aimed at helping the individual researchers and the research teams that have problems in accessing and using computational services for their research activity, and is offered to involve RIs in the process of co-designing and evolving the previous three solutions to meet their requirements;
- **The *Helix Nebula initiative* is providing a channel by which innovative cloud service companies can work with major IT companies and public research organisations**. The Helix Nebula Marketplace (HNX) is the first multi-vendor product coming out of the initiative and delivers easy and large-scale access to a range of commercial Cloud Services, including computing services, through the innovative open source broker technology.

1.3.2.4 PI - Platform Instance

The aim of the Platform Instance is to provide the possibility to have customized versions of the platform that may be devoted to a private company business or to provide for a specific community or commercial services. For this reason we defined two different instances:

- ***PI1 Web-based, public instance*** - a solution like the DRIHM portal

– ***PI2 Private, customized instance*** - a new, separated platform instance where services can be customized (e.g. a new HM moded has been inserted, or a post-processing tool…).

Referring to Figure 7, please note that the set of services included in a platform instance can be customized to fit the user needs. As an example, IS services implement the exploitation of specific data and computational e-Infrastructures, that are not open but accessible following policies based on authorization and accounting rules, so a private instance may include just a subset of them. The same applies to the dashed services.

1.3.2.5 OS - Output Data Services

The aim is to allow the exploitation of the results obtained though different runs by downloading, the possibility to repeat the runs by retrieving the configuration files.

– **OS1 Result repository** - this repository stores the results, i.e. output data, of experiments; the scope of the results is restricted to the user but with the possibility to share them publically visible or with a restricted group of users.

– **OS2 Run configuration data repository** - this repository stores the configuration files of the meteorological-hydrological experiment runs with the aim of allowing the re-run models without the need to calibrate the models.

For the output data services we will evaluate existing infrastructures (i.e. EUDAT).

1.3.2.6 Mapping Use Cases to Services

The project described the initial use cases that provide optimal starting points (to be complemented/reassessed in WP1) for the support of the European initiative in Sections 1.3.1.1 e 1.3.1.2. The mapping between the use cases and the services defined above is presented in the following table.

Use cases	IS	CS	COMP	PI	OS	Users
UC1: new hydromodel at event scale	IS3, IS4, IS5	-	-	P2	-	SMEs, PAs
UC2: EFAS alert	IS1-IS4	C1-C7	COMP1, COMP2	P1, P2	OS1, OS2	SMEs, Pas, RE
UC3: EFFIS Fire risk	IS1-IS4	C1, C7	COMP1, COMP2	P1, P2	OS1, OS2	SMEs, Pas, RE
UC4: RASOR Impact analysis	-	C9	COMP3, COMP4	PI2	OS1, OS2	SMEs, PAs
UC5: innovative actors	IS1, IS2, IS3, IS4, IS5	C1, C2, C3,C4, C5, C9	COMP1, COMP2, COMP4	P1, P2	OS1, OS2	SMEs
UC6: new hydro model seasonal scale	IS3, IS4, IS5	-	-	P2	-	SMEs, PAs
UC7: water resources assessment at seasonal scale	IS1, IS3, IS4	C8	COMP2, COMP3	P1	OS1, OS2	SMEs, PAs, RE
UC8: water quality assessment at seasonal scale	IS1, IS3, IS4	C8	COMP2, COMP3	P1	OS1, OS2	SMEs, PAs, RE
UC9: simplified workflows for citizen	IS1, IS3, IS4	C8	COMP2, COMP3	P1	OS1, OS2	CS

Table 1: mapping between HYEEA use cases and data and computing services.

1.3.3 Leveraging the state of the art

To achieve its objectives, the project domain specific services will be based, when possible, on the re-use and progressive extension of tools and services (TRL 6 and above) from existing infrastructures and projects, such as ones produced by the following projects and initiatives.

1.3.3.1 DRIHM

DRIHM, short for Distributed Research Infrastructure for Hydro-Meteorology, was a project (2011-2015) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 (www.drihm.eu).
The DRIHM project based the design, implementation and deployment of its science gateway and of its Distributed Computing Infrastructure on a set of specific use cases, and its results represent an important evolution for hydro-meteorological research. The project demonstrated the developed capabilities and services considering three main experiment suites:

- **Experiment suite 1 - Rainfall:** a combination of different Numerical Weather Prediction (NWP) HPC models to form a high resolution multi-model ensemble together with stochastic downscaling algorithms to enable the production of more effective quantitative rainfall predictions for severe meteorological events.
- **Experiment suite 2 - Discharge:** a fusion of rainfall predictions (potentially from experiment suite 1) with corresponding observations, which are input into multiple hydrological models, to enable of the production of more accurate river discharge predictions.
- **Experiment suite 3 - Water Level, Flow and Impact:** execution of hydraulic model compositions in different modes to assess the water levels, flow and impact created by the flood events.

The DRIHM experience represented a step beyond the state of the art from different points of view:

- In hydro-meteorology research (Hally et al.[53], 2014) it showed the advantages due to the possibility of combining different multidisciplinary models;
- As a methodology it paved the way to the integration and interoperability of heterogeneous models and data source, e.g. by mean of the MAP approach (Harpham and Danovaro 2014);
- Demonstrated the value of seamless utilization of heterogeneous computing resources, such as PRACE and EGI, in a single workflow (D'Agostino et al.[54] 2014);
- Provided an advanced user interface[55] for experimenting with new model compositions and comparing the impact of different parameter values.

The DRIHM legacy will be fully exploited in the HYEEA project. With respect to the DRIHM goals, this project has a stronger focus on the data management issues from the ICT point of view, it involves more communities and the longer temporal scale addressed requires to tackle a new scientific problem represented by the uncertainty management. Furthermore the evolution from a pure research environment to an operational one is evident.

1.3.3.2 Terradue Cloud Platform

The Terradue data processing infrastructure is based on a Cloud Computing Platform-as-a-Service (PaaS) approach on private (physical deployment over local hardware) or commercial Cloud infrastructures. The Virtual Machines are managed by a **Cloud Controller** based on OpenNebula that includes a **Development Environment** where applications or services are first integrated as Cloud Appliances and eventually moved to **Production Centers** when production ready. These features have a strong potential to speed up the maturing process to TRL 8 for the individual models as they are integrated as platform services.
When fully deployed in production mode, users can instantiate (on-demand) a processing service appliance, provision the appliance on a pre-configured ICT Provider and invoke the processing via the OGC Web Processing Service interface or directly in a Cloud appliance marketplace.

---

[53] Hally, A., Caumont, O., Garrote, L., Richard, E., Weerts, A., Delogu, F., ... & Clematis, A. (2014). Hydrometeorological multi-model ensemble simulations of the 4 November 2011 flash-flood event in Genoa, Italy, in the framework of the DRIHM project. Natural Hazards and Earth System Sciences Discussions, 2(11), 6653-6701.
[54] Dagostino, D., Clematis, A., Galizia, A., Quarati, A., Danovaro, E., Roverelli, L., ... & Straube, C. (2014, November). The DRIHM project: a flexible approach to integrate HPC, grid and cloud resources for hydro-meteorological research. In High Performance Computing, Networking, Storage and Analysis, SC14: International Conference for (pp. 536-546). IEEE.
[55] https://portal.drihm.eu

Terradue implementation extends OpenNebula with Orchestration and Auto-Scaling capabilities for Multi-Tier Cloud Applications in federated infrastructures. The platform is delivered "as-a-Service" to applications developers, providing them with:

- Dedicated application integration environment in the Cloud, with software tools and libraries
- Data collections from distributed EO Data repositories and from Open Data repositories within the Platform
- Data processing chains (data pipeline) supporting different programming models (e.g. MapReduce, Distributed-Shell, graph processing, MPI, TEZ, Spark, Storm etc.)
- Capability to deploy a Cloud appliance (e.g. for on-demand EO data processing) prepared for the processing of a range or category of datasets
- Web Service endpoint to expose the resulting application through as a Web Processing Service (OGC WPS).

The platform includes a **Marketplace** that simplifies the deployment of Virtual Appliances and supports their distribution among the community. The marketplace contains metadata that defines the Virtual Appliances and allows discovery through a catalogue service. The marketplace allows the community to access software applications and services that are built on, integrate with or complements the community developments. It includes generic EO-driven appliances and can also store specific appliances created by new developers. In both cases it allows developers to perform rapid prototyping based on previous experiences and guarantees the reproducibility of results, and traceability of workflow and processes.

1.3.3.3 Terradue Service Integration Support

The Developer Cloud Sandboxes service on Terradue Cloud Platform allows a step-by-step approach on how to deploy, use several EO toolboxes or integrate/create new applications to achieve practical results with high performance processing infrastructures.

This approach allows existing toolboxes and software to be integrated and exploited on distributed compute infrastructures. Once integrated in the provided framework, the application can scale under the automatic. The resulting applications are exposed via the OGC WPS interface to perform the end-to-end validation and subsequently exploit the application in a B2B environment.

The wide usage of virtualization, combined with Docker, significantly simplifies creation of environments and provisioning of resources. Docker is an open platform for developers to build, ship, and run distributed applications. Composed of Docker Engine, a portable, lightweight runtime and packaging tool, and Docker Hub, a Cloud service for sharing light images, Docker enables applications to be quickly assembled from components and eliminates the friction between development and production environments. As a result, user applications can ship faster and run the same process developed in the Developer Cloud Sandbox to large multi-tenant data centers in the Cloud. The main difference between a Docker container and a Virtual Machine lies in the fact that a Virtual Machine consists of, besides of the application itself, also an operating system with all binary files included. Docker images work as an isolated process in the host operating system, which shares a kernel with other containers. Thereby, still using benefits of virtualization, it is more portable and more effective – an application uses less disk space.

The platform allows launching Docker containers directly. The building of the Docker image is part of the application integration output set. When an application is deployed on the processing environment where the resource manager runs it is only necessary to have a simple docker engine operation to deploy the image on the processing container (see section below).

This concept of service integration is an evolution of the ESA's Grid Processing on Demand (G-POD) system, developed and maintained by Terradue, the SuperSite Exploitation Platform (SSEP), and the integration of scientific applications and services for the FP7 EC projects (e.g. GEOWOW, SenSyF) and the experience gained with integration and deployment APIs leveraged within the Helix Nebula initiative. It was an active part of the precursor activities for the definition of the ESA's Thematic Exploitation Platforms reference architecture and is already being applied on the

implementation of the Urban TEP, led by the DLR German Aerospace Center, the Hydrology TEP led by the isardSAT Group, and on the Geohazards TEP lead by Terradue for the implementation and integration of the thematic services.

1.3.3.4 AUTOSUBMIT

While Cloud and Docker are a perfect fit for distributed applications, execution of a massively parallel application requires a closer integration with the computing infrastructure.
Autosubmit is a tool to create, manage and monitor experiments by using Computing Clusters, HPC's and Supercomputers remotely via ssh. It has support for experiments running in more than one HPC and for different workflow configurations. Autosubmit is currently used at Barcelona Supercomputing Centre (BSC) to run EC-Earth, NEMO and NMMB air quality model, and has been used to manage models running at supercomputers in IC3[56] (Catalan Institute of Climate Sciences), BSC, ECMWF, EPCC[57] (Edinburgh Parallel Computing Centre), PDC[58] and OLCF[59] (Oak Ridge Leadership Computing Facility).

1.3.3.5 ESA TEP HYDROLOGY

Water quality and access is essential for socio-economic development and for maintaining healthy ecosystems. Properly managed water resources are a critical component of growth, poverty reduction and equity. The livelihood of the poorest are critically associated with access to water services. The World Economic Forum identified consequently in its Global Risks 2013 report water supply crises among the top two most impactful, and top five most likely global risks.
Current existing EO products and applications relevant for water resource management range from catchment characterization, hydrological modelling, flood mapping/forecasting, water quality monitoring, soil moisture assessment, water extent and level monitoring, irrigation services, urban and agricultural water demand modelling, evapotranspiration estimation to ground water management.
The objective of the TEP for Hydrology, within HYEEA, is to provide scientific and institutional stakeholders and practitioners with a flexible web-based platform to access, explore, and exploit EO-based data and products related to IWRM[60] (Integrated Water Resources Management), to support hydrological science, and streamline exchange of geospatial information and knowledge within the relevant user community.

1.3.3.6 ESA TEP GEOHAZARDS

The Geohazards Exploitation Platform or GEP aims to support the exploitation of satellite EO for geohazards. It follows the Supersites Exploitation Platform (SSEP), originally initiated in the context of the Geohazard Supersites & Natural Laboratories initiative (GSNL). The geohazards platform has been expanded to address broader objectives of the geohazards community. In particular it is a contribution to the CEOS WG Disasters to support its Seismic Hazards Pilot and terrain deformation applications of its Volcano Pilot. The geohazards platform and SSEP are sourced with elements – data, tools, and processing including INSAR – relevant to the Geohazards theme and related exploitation scenarios.
Today the GEP has primary focus on mapping hazard prone land surfaces and monitoring terrain deformation. It allows users to access and exploit large collections ENVISAT ASAR and ERS SAR data hosted in the ESA clusters and in ESA's Virtual Archive. A large collection of ENVISAT ASAR and ERS SAR are available in the platform. In 2014 an additional 40+ Terabytes of ERS and ASAR data was added in response to requirements of the CEOS Pilot on Seismic Hazards. The GEP is also be used to gradually access Sentinel-1A data. The activity also intends to support access to other EO missions' data than from ESA such as from other space agencies and mission owners and operators (https://geohazards-tep.eo.esa.int/).

[56] http://www.ic3.cat/
[57] https://www.epcc.ed.ac.uk/
[58] https://www.pdc.kth.se/
[59] https://www.olcf.ornl.gov/
[60] http://www.un.org/waterforlifedecade/iwrm.shtml

The objective of the TEP Geohazards, within HYEEA, is to provide users, scientific or industrial, tools to run interferometric processing chains in the cloud, resulting in ground motion information. Such data will be further used within value-chain services to tackle landslides monitoring and risk from the combination of Earth Observation and hydrometeorological data.

1.3.3.7 Copernicus

Copernicus is a European system for monitoring the Earth. Copernicus consists of a complex set of systems which collect data from multiple sources: earth observation ***satellites*** and ***in situ sensors*** such as ground stations, airborne and sea-borne sensors. It processes these data and provides users with reliable and up-to-date information through a set of services related to environmental and security issues. The ***services*** address six thematic areas: land, marine, atmosphere, climate change, emergency management and security. The main users of Copernicus services are policymakers and public authorities who need the information to develop environmental legislation and policies or to make critical decisions in the event of an emergency, such as a natural disaster or a humanitarian crisis. Based on the Copernicus services and on the data collected through the Sentinels and the contributing missions, many value-added services can be tailored to specific public or commercial needs, resulting in new business opportunities. In fact, several ***economic studies*** have already demonstrated a huge potential for job creation, innovation and growth. The Copernicus programme is coordinated and managed by the European Commission. The development of the observation infrastructure is performed under the aegis of the European Space Agency for the space component and of the European Environment Agency and the Member States for the in situ component.
HYEEA project will particulary draw upon the Copernicus Emergency Management Service, but also benefit from other services such as the Copernicus Land and Climate Change Service.

1.3.3.8 EFAS

EFAS is the operational pan-European system for monitoring and forecasting floods across Europe funded by the Copernicus Emergency Management Service. It provides complementary flood early warning information up to 10 days in advance to its partners: national and regional hydro-meteorological services and the ERCC.
The aim of EFAS is to gain time for preparedness measures before major flood events strike, in particular for trans-national river basins, both within individual countries and at a European level. This is achieved by providing complementary, added value information through, for example, probabilistic flood forecasts and river basin wide flood information.
The main components of the EFAS hydro-meteorological forecasting chain are: (a) a hydrological model, (b) weather forecasts, and (c) meteorological observations, to update the initial modelstates and for verification purpose. Each of these threecomponents has inherent uncertainty, which can be described inthe modelling framework and propagated to the output discharge. The current EFAS system is a multi-model ensemble approach, in that it accounts for the uncertainty of input weather forecasts usingmodel runs from different meteorological centres in Europe. These include two deterministic forecasts, from the ECMWF (ECMWF-HiRes) and from the German Weather Service (DWD), and two ensemble forecasts, from the COSMO Consortium (COSMO-LEPS) and from ECMWF (ECMWF-ENS).
The twice-daily udated EFAS flood forecasts are accessible through a highly customisable, password protected web platform.
EFAS flash-flood alerts will represent the trigger point for UC2 and UC4, aiming at demonstrating the added value of HYEEA data and computing intensive services for the prediction of flash-flood in small catchments.

1.3.3.9 EFFIS

The European Forest Fire Information System (EFFIS) consists of a modular web geographic information system that provides near real-time and historical information on forest fires and

forest fires regimes in the European, Middle East and North Africa regions. Fire monitoring in EFFIS comprises the full fire cycle, providing information on the pre-fire conditions and assessing post-fire damages. EFFIS uses a large variety of data in its assessments, including meteorological information for fire danger forecast, remote sensing satellite imagery for active fire and burnt area mapping as well as information on fuels, topography, soils, etc. to assess environmental damages caused by fires.
Currently, under the Copernicus EMS-Early Warning component, EFFIS provides fire danger predictions and the near-real time mapping of burnt areas. This information is further used to determine the damage to the land cover affected by the fires. Dissemination of information and data is channelled via the EFFIS web interface, which is open to the public.
EFFIS provides a daily fire danger forecast that is computed on the basis of one of three numerical weather prediction models, belonging to the European Centre for Medium-Range Weather Forecasts (ECMWF), the French (Meteofrance) and the German (DWD) weather services. Fire danger is estimated using the Fire Weather Index (FWI), a method initially developed in Canada and adopted in 2007 as a best practice for harmonised fire danger prediction in Europe.
EFFIS alerts will represent the trigger point for UC3, aiming at demonstrating the added value of HYEEA data and computing intensive services for the prediction of hydro-meteorological conditions able to support the ignition of localized forest fires events.

1.3.3.10 EDO

The European drought observatory (EDO) is a service run by the EC's Joint Research Centre. At the core of EDO is a portal, including a map viewer, a metadata catalogue, a media-monitor and analysis tools. Underlying data stem from ground and satellite observations as well as from distributed hydrological models and are stored in a relational database. Through the map viewer Europe-wide up-to-date information on the occurrence and severity of droughts is presented, complemented by more detailed information from regional, national and local observatories through OGC compliant web-mapping services. The continent-wide meteorological, soil moisture-related and vegetation-related indicators are then integrated into a combined indicator showing different alert levels targeted specifically to decision makers in water and land management. Finally, time series of historical maps as well as graphs of the temporal evolution of drought indices for individual grid cells in Europe can be retrieved and analysed. **EDO alerts will represent the trigger point for UC7 and UC8, aiming at demonstrating the added value of HYEEA data and computing intensive services for water resource/water quality management activities.**

1.3.3.11 RASOR

RASOR, short for Rapid Analysis and Spatialisation Of Risk, is a project (2013-2016) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 (www.rasor-project.eu). Assessing risk is a necessary first step to reducing the exposure of populations and assets to risk and it requires the analysis of three separate elements: exposure, hazards and vulnerability. Documenting them, and understanding how they evolve and interact, are critical to reducing risk. RASOR offers a single work environment that generates or accepts new risk information across hazards, across data types (satellite Earth observation, in situ), across user communities (global, local, climate, civil protection and insurance etc.) and across the world. RASOR developed a platform to perform multi-hazard risk analysis for the full cycle of disaster management, including targeted support to critical infrastructure monitoring. A scenario-driven query system simulates future scenarios based on existing or assumed conditions and compares them with historical scenarios. Initially available over five case study areas, RASOR will ultimately offer global services to support in-depth risk assessment and full-cycle risk management. **The HYEEA modelling outputs will be combined with the RASOR exposure and vulnerability services to drive the RASOR impact modeling services (UC4).**
Moreover HYEEA will rely on the following global horizontal e-Infrastructures:

1.3.3.12 GÉANT

HYEEA IS will build on range of networking services is delivered by GÉANT at the international level. The network services offered by GÉANT include Layer 2 and Layer 3 (IP) services at speeds of up to 100 Gbps. The portfolio includes:

GÉANT SERVICE	DESCRIPTION
IP	The network's standard connectivity service providing robust, high-bandwidth access to and across the shared European Internet Protocol (IP) infrastructure
L3VPN	GÉANT L3VPN offers the reliability and fexibility of the award winning GÉANT IP service combined with the additional privacy of a Virtual Private Network (VPN)
Plus	Provides virtualised point-to-point connectivity across the GÉANT highspeed backbone to support the most demanding of international data requirements.
Lambda	A bespoke service designed to cater for longer term, extremely data intensive network connectivity requirements, providing a dedicated services up to the full 100Gbps bandwidth.
Open	GÉANT Open has been designed as a service to allow NRENs and approved commercial organisations to exchange connectivity in a highly efficient and fexible manner
Bandwidth on Demand	A co-provisioned global multi-domain service that can automatically establish a circuit in minutes, delivering the bandwidth users need, when they need it.

Table 2: GÉANT services portfolio.

In addition, GÉANT manages peering arrangements with a wide range of other networks and providers to increase the effciency of IP interconnections. Together, this portfolio offers the R&E community a comprehensive range of networking solutions to support even the most demanding requirements.

1.3.3.13 EUDAT

EUDAT is the largest pan-European data infrastructure initiative initiated under the EC FP7 programme and is set to move towards a sustainable research data infrastructure. Covering both access and deposit, from informal data sharing to long-term archiving, and addressing identifcation, discoverability and computability of both long-tail and big data, EUDAT services aim to address the full lifecycle of research data. The current suite of EUDAT B2 services is:

EUDAT SERVICE	DESCRIPTION
B2DROP	A secure and trusted data exchange service for researchers and scientists to keep their research data synchronized and up-to-date and to exchange with other researchers
B2SHARE	A web based service for researchers and communities to store and share small-scale research data coming from diverse contexts
B2SAFE	A data management and replication service allowing community and departmental repositories to replicate and preserve their research data across EUDAT data nodes
B2STAGE	A service to ship large amounts of research data between EUDAT data nodes and workspace areas of high-performance computing systems
B2FIND	A metadata catalogue of research data collections stored in EUDAT data centres and other repositories allowing to fnd collections of scientific data quickly and easily, irrespective of their origin, discipline or community

Table 3: EUDAT services portfolio.

1.3.3.14 EGI and PRACE

EGI and PRACE will be candidate to provide their valuable services (see section 1.3.2.3) along the line already experimented in the DRIHM project and widely addressed in technical paper

D. D'Agostino et al. (2014[30]). No further details are provided here, but the availability of new services by PRACE and EGI will permit to improve their use within HYEEA.

1.3.4 Gender analysis

Gender equality is a common value of the European Union, as outlined in the "Strategy for equality between women and men 2010-2015". The HYEEA partners support policies advocating equal opportunity for women and men, and specifically support the involvement of women in their field of activities. HYEEA fully respects sex and gender considerations, incorporating the concerns and experiences of women and men in the project activities – incl. in management, implementation and communication of results. The partners are committed to involve men and women across the project activities in a balanced way. At the consortium level first, 5 women will be involved, representing 29% of the personnel involved in the project; 4 of them will hold important roles (WP or tasks leader) in the project's implementation: 15% of the Work Packages will be led by women. Furthermore A preliminary sex and/or gender analysis has been undertaken on the basis of the EC Engineering Checklist[61], considering questions relevant for HYEEA. The answer to all questions in groups A and B (1-12) is "No" and the answer to questions 19 and 20 is "Yes".

1.4 Ambition

The project ambition is to provide a substantial progress beyond the start-of-the-art in the study, evaluation, prediction of natural hazards and their social/economic/environmental impacts, from the event scale to the seasonal scale through seamless access to the modelling and observational datasets as well to socio-economic impact analysis tools. The scope of the work is defined by the needs of users, ranging from profit-making users (e.g. SMEs), go public admininistration users and research users, for applications that will enhance the capability of bringing to the ground the effects of natural hazards scenarios and thus, in the long run, to increase resilience of communities and countries in responding to the associated hazards.

The natural hazards areas considered by the HYEEA project are:

- **Flash-floods**
- **Wildfire**
- **Landslides**
- **Droughts and in general water resources/water quality management**

This selection is sufficiently broad to capture key areas in which the HYEEA DRM services can help to gain a deeper understanding of natural hazards impacts and thus an improved predictive capability.

Each of the aforementioned natural hazards areas is now analysed in detail in terms of direct impacts, interested actors, research and operational questions and possible benefits ensured by the HYEEA services.

Flash-floods

What are the main direct impacts? – Possible casualties from drowning / collapse of buildings / burial in landslides; distress to people who have lost relatives / are injured / made homeless; displaced people, disruption to services (education, health etc), business interruption, surface water flooding; sewer overflows; landslides/mudslides; river overtopping; breach of levees / flood defences; transport links cut; water/energy infrastructure put out of action.

Who are the interested actors for projects results and activities? – Research institutions active in natural hazards DRM studies; national government; city authorities; emergency managers; voluntary response sector; SMEs; public; insurance companies.

Which are the key research and operational questions? – Probability / timing / locations of threshold exceedance (depth & velocity) at key decision lead times; timing of defence overtopping / breach; duration of flood and flash-flood; probability / timing/speed of landslide

[61] http://ec.europa.eu/research/science-society/gendered-innovations/index_en.cfm

What could we provide if HYEEA will be funded? – Contribution through a probabilistic approach to the improvement of the prediction of flood and flash-flood and related impacts; provision of probabilistic information at a variety of lead times and spatial scales; improved quantification of prediction uncertainty; guidance on how to communicate forecasts and warnings to citizens; provide an environment to test the efficiency of risk mitigation strategies; provision to SMEs of state-of-the-art computing and data storage services to develop innovative services in the DRM area; provision to PAs of state-of-the-art computing and data storage services to improve the predictive ability of flash-floods in regions of interest.

Wildfire

What are the main direct impacts? – Possible casualties from burns / smoke inhalation / stress; population made homeless (temporarily or over longer time period); burned natural & crop vegetation erosion in subsequent rain; transport links cut; loss of business due to damage / transport disruption; disruption of public services due to damage / transport disruption;

Who are the interested actors for project results and activities? – Research institutions active in natural hazards DRM studies; national government; rural authorities; emergency managers; voluntary response sector; SMEs; public; insurance companies.

Which are the key research and operational questions? – Early warnings of potential scale (area, duration) and impact; probability of threshold exceedance (fire danger) at key decision points; probability of ignition; fire initiation, movement / spread velocity – timing of changes, fire intensity/temperature; fuel state; smoke density, plume spread direction & speed, composition, height & thickness; prefire staging of movable wildfire suppression resources across geographic locations;

What could we provide if HYEEA will be funded? – Contribution through a probabilistic approach to the improvement of forecasts of extreme conditions of temperature-humidity-wind; improved prediction of soil & vegetation moisture content in fire risk forecasts; identify/share best practice in fire risk index prediction; communicate the meaning of high fire risk more effectively to citizens; provision to SMEs of state-of-the-art computing and data storage services to develop innovative services in the DRM area; provision to PAs of state-of-the-art computing and data storage services to improve the predictive ability of wildfire in regions of interest.

Landslides

What are the main direct impacts? – Expected damages from low, allowing the construction of buildings and/or structures over the mass surface with some precautions, to very high, yielding to many deaths, the destruction of buildings and structures, displaced people, public and private services interruption.

Who are the interested actors for projects results and activities? – Research institutions active in natural hazards DRM studies, planning and development authorities, organizations managing transport networks and utilities, agricultural and forestry agencies, civil protection authorities, insurance companies and emergency management authorities.

Which are the key research and operational questions? – SAR Interferometry performance over vegetated scenarios in mountainous environments, reduction of geometrical and temporal decorrelation phenomena, reliable response with a reduced number of SAR images, minimize SAR geometrical distortions, reduce the impact of rapid atmospheric artefacts correlated with the topography, improve the performance over scenarios with steep topography, detect rapid landslide events.

What could we provide if HYEEA will be funded? – Contribution with of SAR-based solutions for motion mapping in slow-moving landslides (PSI) and rapid events (Speckle Tracking). Improvement of PSI solutions by employing Global Atmopheric Models (ERA-I from ECMWF) for tropospheric stratification mitigation. Study of hazard risk/indicators through the combination of the aforementioned SAR solutions and rainfall, flood and wildfire information.

Droughts and in general water resources/water quality management

What are the main direct impacts? – Lower water levels in reservoirs, lakes, and ponds; loss of wetlands; more wildfires; wind and water erosion of soils; poor soil quality; farmers may lose

money if a drought destroys their crops; water companies may have to spend money on new or additional water supplies; health problems related to low water flows and poor water quality.
Who are the interested actors for project results and activities? – Research institutions active in natural hazards DRM studies; national government; rural authorities; emergency managers; voluntary response sector; SMEs; public; insurance companies.
Which are the key research and operational questions? – Poor understanding of direct global warming impact on drought; need to further assess the potential role of land; further assess precipitation variability and meteorological drought; improvement of seasonal forecasts requires better observations; interdisciplinary knowledge from recent (and current)
regional case studies, including socio-economic and ecosystem impacts; improving tools for drought decision‐making under climate change.
What could we provide if project will be funded? – Contribution through a probabilistic approach to the improvement of forecasts of weather conditions leading to droughts on sub-seasonal and seasonal basis; improved prediction of soil & vegetation moisture content in drough risk forecasts; identify/share best practice in drought prediction; communicate the meaning of high fire risk more effectively; provision to PAs of state-of-the-art computing and data storage services to improve the predictive ability of droughts in regions of interest; nesting droughts scenarios at different levels; linking drought scenarios and decision tools.
The project innovations and strength are further represented by:

- Extensive use of science gateway technologies that permit to set up a flexible and extensible portal for multidomain scientific experiments;
- Interoperable workflow and model execution management that permits a seamless access to heterogeneous distributed computing resources;
- Most of the services will be available through dedicated API that will enhance interoperability and provide support to mashup and interoperability with other systems;
- Ready to go execution of multi-model ensemble predictions and data both at local and global scales;
- Accessing state-of-the-art event scale to seasonal modelling data, as provided by the ECMWF databases, together with exposure and vulnerability data, offered by RASOR;
- Full standards compliant and extendible services for input (section 1.3.1.3) and output data, including Grib, netCDF, WaterML, Web Map Service Interface Standard (WMS) and the Web Coverage Service (WCS);
- An extensible and rich set of domain specific models, enabled both for deterministic and ensemble workflow executions, where all the models belonging to the same application area are interchangeable;
- An advanced and complete portofolio of loss modelling tools to evaluate the natural hazards impacts

2. Impact

2.1 Expected impacts

As the aim of the project is supporting rapid e-Infrastructure development targeting European initiatives that have different needs for innovative DRM services, the direct impact of the project will emerge through the following channels (in rough chronological order):

- Raised stimulation of innovative potential of users and providers of e-Infrastructures by improving products and services offering for areas with increased societal impact;
- Increased efficiency in the processes of the European initiatives, leading to
    - Direct increase in the capacity of their ongoing activities targeting societal challenges;
    - Reduced opportunity cost (e.g. eliminating the waiting time for different data products, reducing costs of multi-model simulation development and execution) that allows launching new activities that not so far been feasible due to resources constraints originating from ICT-related limitations;

- Increased cohesion of the research and innovation ecosystems around the European initiatives, leading to faster inter-organisational plan–do–check–act (PDCA) cycle and faster deployment of new, innovative DRM solutions across these initiative-specific ecosystems;
- Increased potential for inter-organisational collaboration through shared tools and approaches, achieving the criticial mass (that is needed e.g. to go from demonstration of a technical improvements to mainstreaming policies needed to reap the full benefits in disaster risk management across the member states) more rapidly;
- Support for technical outreach and community engagement activities of the European DRM-related initiatives;
- Improve business opportunities for SMEs and allow for effective exploitation of Copernicus downstream services.

Overall, the ambition of the project is to become part of the reference services at the European level for the study, evaluation, prediction of natural hazards and their social/economic/environmental impacts.
With such goal in mind, the expected impacts include:

2.1.1 To accelerate the development of innovative data and computing intensive services in areas of social relevance

HYEEA project will promote smooth collaboration between DRM related platforms such as EFAS, EFFIS and EDO (already TRL8 in nature), and DRIHM, ESA TEP Hydrology, and RASOR (now TRL6 in nature). This will enable the development of innovative data and computing services described by the HYEEA event scale modeling use stories (section 1.3.1.1) and by the HYEEA seasonal scale modeling use stories (section 1.3.1.2) to meet new challenges in the disaster risk management (DRM) cycle of natural hazards from their onset to the subsequent social/economic/environmental impacts.
Thus, HYEEA services will contribute to address the following EC societal challenges:

EC Societal Challenge & Societal Benefit Areas (SBA)	**Actions**	**EU initiative**	**Specific Requirement**	**Project approach**
Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy[62]	Ensuring sustainable management of natural resources and climate action	Climate-KIC Copernicus	Providing results of seasonal forecasts to public administrations	Providing seasonal forecasts (water resources/water quality and forest fire) services in a standardized form to public administrations
	Balanced territorial development of the EU's rural areas and their communities	Climate-KIC	Providing results of seasonal forecasts to public administrations	Providing seasonal forecasts (water resources/water quality and forest fire) services in a standardized form to public administrations
Secure, Clean and Efficient Energy[63]	Smart Cities & Communities	ICT-KIC Copernicus	Improve probabilistic modelling and visualisation of	Build on the foundations of the DRIHM and RASOR projects to provide mature probabilistic workflows and visualisation

[62] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/food-security-sustainable-agriculture-and-forestry-marine-maritime-and-inland-water
[63] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/secure-clean-and-efficient-energy

			natural hazards risk on european scale	services based on e-Infrastucture services public administrations
		Climate-KIC, ERCC, Copernicus UNISDR[64]	Providing results of natural hazards forecasts to local emergency authorities.	Improving communication between forecast and local autorities.
Climate Action, Environment, Resource Efficiency and Raw Materials[65]	To achieve a resource – and water - efficient and climate change resilient economy and society	Climate-KIC Copernicus UNISDR[64]	Providing results of seasonal forecasts to public administratios	Providing detailed seasonal forecasts (water resources and forest fire) services in a standardized form to public administrations
		EIT-DIGITAL	From smart cities to smart citizens	Active, collaborative and sharing-oriented citizens as part of the DRHM virtuous loop
	The protection and sustainable management of natural resources and ecosystems	ERCC Copernicus	Improving the local facilities for the protection during NATURAL HAZARDS. The more specific the knowledge of the local authorities is, the more efficient the protection stragedy.	Providing detail seasonal forecasts (water resources and forest fire) services in a standardized form to public administrations
The EU Strategy on adaptation to climate change[66]	Action 4: Bridge the knowledge gap	Copernicus	Identify adaptation knowledge gaps and the relevant tools and methodologies to address them	HYEEA overall services for the study, evaluation, prediction of severe weather scenarios (flash-flood, forest fire and droughts) and their social/economic/environmental impacts
	Action 6: Facilitate the climate-proofing of the Common Agricultural Policy (CAP)		Further integrate adaptation into the CAP	Providing detail seasonal forecasts (water resources and forest fire) services in a standardized form to public administrations
	Action 8:		Improve the	HYEEA catastrophe and socio-

[64] EC is the major donor to UNISDR (https://www.unisdr.org/who-we-are/donors)
[65] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/climate-action-environment-resource-efficiency-and-raw-materials
[66] http://ec.europa.eu/clima/publications/docs/eu_strategy_en.pdf

	Promote insurance and other financial products for resilient investment and business decisions		market penetration of natural disaster insurance in investment and business decisions	economic impact modeling services

Table 4: EU societal challenges addressed by HYEEA data and computing services.

2.1.2 Bridge the gap between adjacent but not connected scientific communities

HYEEA will target a multi-disciplinary area of science and technology involving the hydrology, hydraulics, geology, meteorology, climatology and computer science communities. The HYEEA services has the potential to enable an unprecedented cooperation between these communities in data and model provision and exchange to cover the full disaster risk management (DRM) cycle of natural hazards from their prediction to the subsequent social/economic/environmental impacts. HYEEA will stimulate and require the integration of data from a large number of resources with special emphasis on natural hazard modeling and observation (section 1.3.1.3) and also their impact assessment. HYEEA DRM communities bridging will result in higher efficiency and creativity in science as well as in higher productivity of profit-making (SMEs) and PAs users, thanks to reliable and easy access to discovery, access and re-use of data. Furthermore an acceleration in innovation in DRM science and operational activities will be enabled via an integrated access to potentially unlimited digital research resources, tools and services across DRM disciplines and user communities. Finally the possibility for HYEEA users to process structured and qualitative data in virtual and/or ubiquitous workspaces will be another contribution to bridge the gap between the aforementioned DRM communities.

2.1.3 Knowledge capital better preserved for further exploitation by future digital-born generations

HYEEA services will enable a substantial progress in the European DRM capacity to deal with natural hazards, spanning from flash-floods to droughts through forest fires by the integration of DRM related platforms such as EFAS, EFFIS and EDO (already at TRL8), and DRIHM, ESA TEP Hydrology, and RASOR (maturing from TRL6).
Researchers will be able to take full advantange of the HYEEA services to better understand the underlying physics of these phenomena; profit-making users (e.g. SMEs) and PAs (e.g. environmental agencies at the regional level) will have access to an unprecedented amount of data and computing services supporting their activities, with a special focus on the socie-economic impacts of these events, and potential prevention/mitigations actions.
Citizen will have both intrinsic (e.g. increased scientific literacy through the project dissemination activities) and extrinsic benefits (e.g. increased social awareness, as in the case of improved prediction and prevention of natural hazards)
All together this implies that the position of different DRM user communities in the HYEEA ecosystem governance will be impacted and strengthned on four levels:

- On the strategic level HYEEA user communities will have to organise themselves to drive the long-term strategy (WP2 and WP6);
- On the service provision level HYEEA user communities will have to learn to use their joint purchasing power in a competitive market;
- On the innovation level HYEEA user communities should support the specification and real-life testing of new HYEEA developments;
- On the standardisation level HYEEA user communities should contribute to the process of setting and implementing the international standards necessary to support the sustainability of HYEEA services and to consolidate them towards an international, service-oriented, DRM e-Infrastructure portfolio.

2.1.4 To increase the number of SMEs that are aware of available e-infrastructures resources and become active innovators as users and or suppliers

Users dealing with DRM science and operational applications are increasingly interested, commonly with many other disciplines, in integrated services focused on their own problems, and much less in who delivers these services. Ultimately, DRM users, especially SMEs, want to be presented with user-friendly access to all e-infrastructure services they might need. Information and communication technology based resources and services are not, by definition, the users' core business, so neither are e-Infrastructures. To be efficient, SMEs need to concentrate on their core business, using coherent e-services that should be sufficiently simple to use and not costly to manage. HYEEA services ecosystem, leveraging and increasing the interoperability of thematic DRM e-Infrastructures, will certainly pave the way to potential economies of scale, e.g., by HPC, grids and clouds, or open up the opportunity to cost effectively address a much wider range of research and operational DRM challenges than distinct ones.
Cooperating e-Infrastructures in the field of DRM such as EFAS, EFFIS and EDO (already TRL8 in nature), and DRIHM, ESA TEP Hydrology, and RASOR (now TRL6 in nature) will enhance the opportunities for cooperation, e.g., by open networking, international grids or clouds and by offering common data and modelling services, thus facilitating the access to resources by innovators such as SMEs and scientists, as depicted in the HYEEA user stories.
Then the impact for SMEs can be summarized as:

- Direct cost saving in prototyping and development of innovative networking, data and computing intensive application and services;
- Productivity improvements: changes business activities can be achieved without the need for changes to installed technology or new technology purchases
- Innovation: SMEs can gain further benefits in business flexibility, and agility and collaboration, by taking new DRM services in production and to the market.
- There may be new business opportunities, models and optimisation approaches that emerge from the broader, open availability of DRM-related services and datasets. For example, weather information is already used to manage volatility of demand and supply in the supply chains operations of global companies, and HYEEA will contribute to democratisation of such approaches and making them available to SMEs, too. The economic impact of overall supply chain optimisation can be considerable, e.g. 2013 PWC[67] study found that optimisation of supply chain processes could achieve ca. 15 percent improvements in the profit margins (EBIT, earnings before interest and taxes, comparing leaders and laggards in different sectors), thus ability to turn seasonal forecasts into actionable information might be basis for new consulting services

2.2 Measuring the project's impact: Key Performance Indicators

The project sets a number of goals and performance indicators (Key Performance Indicators or KPIs for short) for its activities, ranging from the very high-level goals that can realistically be reached by the end of the project lifetime to more fine-grained indicators that can be used to track project's progress and act as input to overall project and risk management activities.
As the project's goal is to support European initiatives, these KPIs need to set slightly differently from traditional projects that try to maximise the independent impact of the project. Hence e.g. the success in dissemination activities will not be primarily gauged by the size of the audience the project can gather, but on the visibility of the project's announcements, mainly by being promoted (e.g. retweeted or shared) by the European initiatives supported by the project. In addition to ensuring that the KPIs are aligned with the core purpose of the project (supporting the initiatives), especially in the dissemination area there are good, pragmatic reasons to de-emphasise metrics that measure project's visibility outside the context of the initiatives it collaborates with: for example, UNISDR's Twitter account has almost 40 000 followers, which is

[67] https://www.pwc.com/gx/en/consulting-services/supply-chain/global-supply-chain-survey/assets/global-supply-chain-survey-2013.pdf

two orders of magnitude higher than what is realistically achievable with reasonable effort in a project that is focused on technical developments.
Using this logic, the project has defined the following initial set of key indicators and their target values is the following (from the major goals to fine-grained indicators):

- Number of applications handed over to European initiatives or organisations closely linked to them. This goal is considered fulfilled if the overall responsibility for the sustainability of the tool has been handed over.
    - *Target at the end of the project: one service handed over*[68]
- Number of applications with clear sustainability plan, including a plan for handing over the responsibilities to a European initiative
    - *Target at the end of the project: five services with a clear sustainability plan*
- Number of exploited third-party data repositories and service providers
    - *Target at the end of the project: five data repositories*
- Percentage of external attendees/contributors to the project workshops:
    - *Overall target at the end of the project: 50%*
- Timeliness in deliverables and milestones submission:
    - *Maximum acceptable delay: 2 weeks*
- Number of datasets, algorithms, and tools accessible through the HYEEA e-Infrastructure
    - *Target values:*
        - 1st year: 2
        - 2nd year: 4
        - 3rd year: 8
- Number of users exploiting the HYEEA services on a regular basis: HYEEA plan is to create a directory of potential users, provide information to at least the 50% of them and involve at least 5 (a part of them) new user per year in experimentation.
- Number of SMEs providing resources (models and/or data) to and using the HYEEA e-Infrastructure services: HYEEA plan is to create a directory of potential interested SMEs, provide information to at least the 50% of them, and involve at least 5 (a part of them) new user per year in experimentation.
- Number of incoming links to the project website (or social media followers) from the European initiatives supported
    - Target values:
        - 1st year: 4
        - 2nd year: 8
        - 3rd year: 10
- Number of social media posts shared by the supported initiatives (initial criteria: a non-sponsored reach of over 500 users on Facebook or over 1000 impressions on Twitter as reported by the platforms[69])
    - Target values:
        - 1st year: 2
        - 2nd year: 6
        - 3rd year: 10

In addition to these formal metrics, the project will monitor the statistics of the project website. While there are no specific KPIs, the project will use the data e.g. following ways:

- Look for major spikes of interest and analyse the reason to find out of they represent new exploitation opportunities

[68] It should be noted that this is an extremely ambitious goal, since achieving this means that not only a "client initiative" sees value in the service provided, it is also motivated to invest in sustaining the service that it could get for free until the end of the project (e.g. in order to release HYEEA consortium's resources in the development of new services)
[69] This criterion is a fairly reliable indicator that an external social media influencer (in this case most likely a European initiative supported by the project) has passed the message on through its own channel. The number of "false positives" is very low, although the metric may miss some of the cases where a retweet has occurred through a specialised channel or e.g. during holiday period.

- Analyse the size and behaviour of the "core" community by tracking the number of page views and lengths of the visits to the website by the repeating visitors. In case these numbers indicate possible drop in the size of the committed team or the degree of cohesion within it, the issue will be raised through the normal risk management procedures.[70]

2.3 Measures to maximise impact

2.3.1 Dissemination and exploitation of results

Primary channel: uptake by the initiatives supported by the project (exploitation) and using their dissemination channels to promote success stories. To motivate this, the project will aim at increasing the awareness of the work of the European initiative in the DRM domain in the broader technical domain, using the dissemination channels of the e-Infrastructure intiatives to illustrate the technical challenges DRM activities face in more detail.
As discussed in Procter et al (2012), users often feel that e-Infrastructure and/or cyberinfrastructure services are too remote and not easy to find and to use. This remoteness supports a sort of 'intellectual distance', inhibiting the real engagement between computer scientists and the user communities. To counter this, HYEEA will seek to encourage closer collaboration between HYEEA partners, both on the natural hazards and ICT sides, and external users so that the former have a better understanding of the latter's requirements and the latter have a better grasp of the opportunities available to innovate their research methods and practices (WP1). For HYEEA results to have value and impact, the information created must be communicated to relevant stakeholders, such as profit-making users (e.g. SMEs), public administrations, and research users and national and international DRM agencies.
The communication strategy during the project lifetime is linked with the key impact goals as described in section 2.1. The activities related to these goals will be sustained by ensuring that they provide sufficient added value (e.g. in terms of larger potential user base or deeper engagement and retention of the current user communities) that the efforts needed to maintain the technical solutions will be relatively easy to provide based on relatively modest contributions from the resource owners. The exceptions to the above are the activities that require long-term personal interaction, such as training events (workshops) and consulting activities (supporting establishment of national climate services). In both cases the project aims at building a model where these services can be provided either by third parties ("train the trainers" approach during the project lifetime) or services by one or more of the project partners (either as commercial services or based on some kind of in-kind contributions or compensations).

2.3.2 Business plan (financial sustainability)

As mentioned in the previous section, the costs of the basic software maintenance are relatively modest, as long as the underlying e-Infrastructure does not undergo fundamental changes. In this context switching between different dedicated and/or Cloud-based solutions for hosting the HYEEA components will not constitute a major change. Hence we estimate that the minimum staff input or "skeleton crew" for maintaining the solution would be considerably less than 1FTE, ideally split between two or three experienced developers. The consortium has already identified permanent staff positions (in CIMA, LMU, CNR-IMATI and ECMWF) that can cover this maintenance role (including advanced developer support). This task is also somewhat simplified by the adoption of the standard "CC-BY" licensing model, which simplifies the due diligence needed when collaborating with external contributors. The activities requiring more substantial resources (adaptation of applications to HYEEA use and verifying the correct functionality, training and education, consulting) will be approached on case-by-case basis. The personnel in the software maintenance role will also be the initial contact point, outlining the different options based on the availability of the staff and the specific constraints of their host organisations (e.g. non-profit status preventing some tasks or necessitating approaches such as in-kind contributions

[70] The size of the strongly committed core community is largely irrelevant (up to a point), however fragmentation of the core team (indicated either as diminishing size of the community or decreasing interest) is a risk factor as these trends can very easily become self-reinforcing vicious circles.

etc). Hence, the "revenue model" needs to consider numerous options (i.e. "government funds; income from services offered to other research projects; and income from services to industry") as well as sponsorship from industry (e.g. corporate social responsibility programme of a hosting provider paying for some of the computing/data storage costs), private foundations and so on.
Independently of the option chosen, the services will be initially managed relying on accounting, invoicing promotional services of CIMA on behalf of the whole consortium. If establishing a separate legal entity for HYEEA sustainability will be seen as beneficial, these tasks will be moved to this new entity. The project will also develop methods for capturing the incidental "evolutionary" benefits to researchers, model developers and other stakeholders who have collaborated with HYEEA. By providing quantitative or qualitative indicators that HYEEA can contribute to more successful modelling software can be a strong complementary argument for in-kind donations and other mechanisms to support HYEEA in the long term. These results could also form a basis for consultancy services that could either provide HYEEA additional revenue or be basis for a spin-off activity. In case this (or some other service- or technology-based innovation) seems to have commercial potential, the project will leverage all possible innovation support services available to the partners, such as Eurostars programme and various national instruments (such as the "Innovate UK" programme). Last but not least, the introduction of new HYEEA services for DRM communities will enable new application domains, and may generate new areas of applications altogether. These new areas may bring additional funding to the e-Infrastructures, which can then increase their services capabilities and characteristics. Additionally, public organization (e.g. Civil protection, hydro-meteorological prediction agencies, etc) might want to contribute to the investments of e-Infrastructures, if the applications are beneficial for society.

2.3.3 IPR and data management

The IPR strategy is based on maximising the take-up of the solutions developed and in that way building a vibrant, open ecosystem for services and products building on the HYEEA platform. To meet these goals, the recommended Creative Commons variant CC-BY provides one of the optimal approaches, which the project will elaborate in more detail in the Consortium agreement (based on the DESCA 2020 model, using the option where all the project results are available for exploitation by any of the partners, without remuneration). This license will be applied both to the software being developed, as well as most of the material used to support promotional and educational HYEEA activities (the exceptions may need to be taken in case the quality and suitability of the material will be considerably improved by including components with more limiting license, for example graphics or photos that would be costly to replace with CC-BY compliant material).
To minimise IPR-related risks – both for the project consortium and the users of the HYEEA components and services – the software release process (described in more detail in section 3.2.2 Quality assurance on page 65) includes an IPR review of the software components. This minimises the risk of disruptions HYEEA users could face through claims of IPR infringement. In addition to being linked project website, the software will be included on one of the popular software repositories (such as GitHub). The choice of the hosting solution will be made based on market analysis done in the WP1 before the kick-off.
To minimise delays in the broader availability of the major publications, HYEEA will prioritise the use the Gold model for its publications. In case the publication is less central (such as a discussion paper in a conference or a technical note), the Green option may be used. In both cases, the papers will be distributed both through the project website and the software repository chosen. Concerning the data production and management, HYEEA will adopt the following policies:

What types of data will the project generate/collect?
HYEEA will provide access to different modelling and observational data relevant for the natural hazards prediction and prevention. The data generated from the meteorological models in probabilistic mode, because of their amount and size, will be archived in agreement with CMIP5 recommendations. In principle HYEEA will be agnostic to the IPR and licensing scheme of the data

generated by the users. It will display the license and manage access rights - however, it can't automatically prevent issues such as one user generating a variant of dataset that has been licensed as "no variants". The platform itself will generate mainly statistical data related to the usage of the different resources, with the "raw data" kept private but anonymous, statistical data can be made public.

What standards will be used?

The project needs to take into account and integrate developments in several different standards, arising from different sources. To manage this complexity, the standards are categorised based on which HYEEA component they have a potential impact on. The project will also highlight standards that have a high impact on the development of models to be integrated into the HYEEA system. The following table lists a set of known, candidate standards, their impact on HYEEA development as well as the project's intended approach to influence the related developments. The standards-related developments in areas influencing the HYEEA API (as listed on the "Interface" column in the table below) are coordinated by WP3.

Standard	Category	Interface	HYEEA approach
netCDF-CF1.6	Environmental data	Yes	Relevant for observational and modelling gridded data as well as for data exchange among model instances
CF (Climate & Forecasting)	Environmental data	Yes	Relevant for gridded data as well as for data exchange among models
WaterML 2.0	Environmental data	No	Relevant for observational and modelling data point and timeseries
APIs	Environmental data	No	Relevant for access input data for the HYEEA workflows
ISO19139	Numerical models	Yes	Metadata standard for new model engines to be added to the HYEEA workflows
OpenMI2.0	Programming API	Yes	Relevant for run time data exchange between models, databases and tools in the HYEEA workflows
Grib2	Environmental data	Yes	Relevant for observational and modelling gridded data as well as for data exchange among model instances
Web Map Service (WMS)	Environmental data/numerical models	Yes	Relevant for requesting geo-registered map images from one or more distributed geospatial databases to be used in the HYEEA workflows
Web Coverage Service	Environmental data/numerical models	Yes	Relevant for requesting coverage data in forms that are useful for client-side rendering, and/or as input into HYEEA workflows
CF and CSDMS	Environmental data (parameter names)	Yes	Adapt as much as possible existing standard names; in case suitable controlled name doesn't exist, submit community standard proposal.

Table 5 HYEEA standards approach.

How will these data be exploited and/or shared/made accessible for verification and reuse?

The strategy for HYEEA related research data management, i.e., caring for, facilitating access to, preserving and adding value to research data throughout its lifecycle, will follow strictly the corresponding national and European regulations. All dissemination and exploitation activities will be aligned with the European priority of Horizon2020 for open access to scientific data and results that are obtained using public financial support. This will help to increase exposure of the achievements and to stimulate cross domain collaboration for natural hazards DRM, which are important issues for the successful fulfilment of the proposed HYEEA e-Infrastructure goals. Data and other results that HYEEA owns (or that have been licensed to HYEEA) will be made available

through electronic archives (similar to "green open access") for a long period. This includes also scientific papers resulting from HYEEA activities. To support a long-term sustainability plan, HYEEA will follow as much as possible established and emerging standards for data management. In particular, all data generated while simulating and assessing the HYEEA use cases, will not only be publicly available, they are also intended to comply to respective standards – as outlined in the Table 5. The project will ensure that all data and results can be discovered and integrated into the Copernicus Climate Change Data store as well as the equivalant counterparts on the Copernicus Emergency Managament Service. Integeration into other Copernicus Services is desirable and opportunities will be explored.

How will these data be curated and preserved?

Core features of the HYEEA data curation and preservation approach take into account technologies, organizational structures, and human knowledge and skills and can be summarised as:

- Preservation-ready system:. facilitating preservation is a core element of the HYEEA platform. This requires a multi-faceted approach, involving technical approaches to capturing data, metadata, and provenance information, as well as preservation-specific organizational policies and practices;
- Flexible data model: the data model at the core of the HYEEA project will be developed to be conducive to managing and preserving diverse types of data resources;
- Ingest and search-and-access Application Programming Interfaces (APIs): the HYEEA Instance enables additional and external services to be built on top of the core software components via the Ingest and search-and-access APIs;
- Customizable user interfaces: the HYEEA Instance can be customized to meet the needs of specific deployment contexts;
- Scalable storage solution: the underlying archival service of the HYEEA Instance enables millions of digital objects to be ingested and managed.

2.3.4 Communication activities

Effective communication of HYEEA results includes disseminating the information to the people that need and can use it, through appropriate channels, and conveying the information so that it is correctly understood, interpreted, and used. The key challenges in accomplishing this are:

- Understanding different audiences' capabilities, needs, perspectives, and decision processes so as to communicate effectively with multiple audiences (different user sectors, and different audiences within "the public");
- Defining audiences and goals for communicating with those audiences, in order to design effective communication strategies and measure success;
- Using theories, knowledge, and methods from fields such as communication of health risks and hazards to help guide natural hazards DRM communication research and practice;
- Taking into account rapid changes in natural hazards DRM communications (such as internet and mobile communications as well as social media)

To support these specific dissemination goals outlined in the previous section, as well as the overall visibility of the project, the project will maintain an "Outreach mapping document" linking audiences, publications and other dissemination material and dissemination channels. An initial mapping is presented in the table below:

Audience	Publication types	Channel
General public	Infotainment (success stories, personal profiles, case studies,…)	Project website + social media, Wikipedia updates
Next generation users	Infotainment, career opportunities and career path descriptions, high-level technical summaries	Project website + social media (as above + LinkedIn, Reddit)
Model developers	Short write-ups ("HowTos") addressing concrete issues and limitations model developers might encounter.	Technical and open source-oriented publications and forums

Emergency management officials	"Advanced user guide" that explains the opportunities and limitations of the model chains (with a specific focus on issues such as propagation of uncertainty) without going into implementation details	Personal (peer-to-peer) contacts, professional bodies and international organisations such as WMO
Policymakers	Briefing focusing on the potential savings and/or added value of HYEEA DRM services	International organisations, media

Table 6: communication activities mapping.

3. Implementation

HYEEA networking activities

To achieve the overall project's objectives a series of Networking Activities (NAs) are designed to facilitate the co-operation between the project partners and within/between hydrology, hydraulics, geology, meteorology, climatology and computer science communities. Engagement of all of these communities is crucial for HYEEA project to fulfil its goals in terms of building (through Joint Research and Service activities) an e-Infrastructure that supports optimally rapid application development to address specific requirements of the supported initiatives and creates optimal services to study natural hazards from the event scale to seasonal scale.

Generally speaking, before users (from the networks of the European initiatives supported, or individual profit making, PAs, and scientists) can decide to make use of a given e-Infrastructure, they need to be aware of the services available, what they provide and how to select between different options. Awareness can be raised through a number of different mechanisms, such as leveraging the existing channels within the initiatives supported, existing e-Science support centres or the e-Infrastructure service providers, dedicated training courses/schools, and conference presentations, workshops and seminars in ICT and DRM events. Therefore, the dissemination of the results and activities, the promotion of the interplay and cooperation with related projects, the engagement, training and education of new users and young scientists, and the promotion of long term — i.e., beyond the end of the project — sustainability plays a key role in the design and implementation of HYEEA. Due to this strategic role networking activities play, the basic dissemination activities have been closely integrated with the activities that are more technical in nature (such as provision of pilot experiments/demonstrations that support addressing HMR and Fire risk assessment by the supported initiative). The project dissemination need to be perfectly aligned with the experiences gained from the practical work, as exaggerated or otherwise misleading (even unintentionally) statements in the outreach material would not only harm the project but also its relationship with the initiatives it supports.

Accordingly, besides the activities to manage the project itself (WP7), Networking Activities will be installed for dissemination and user engagement (WP6): the target of these activities will be different classes of users to demonstrate the potential and added values of the data and model intensive services to address: event scale flash-flood forecast experiment, event scale forest fire forecast experiment, and seasonal scale forecast experiment for water resources/water quality management. Another success factor is the publication of project results on peer-reviewed DRM and ICT international journals.

- The project will plan adequately resourced activities devoted to dissemination, both to specialised constituencies and to the general public, for awareness raising and educational purposes. The dissemination plan will therefore consider how best to convey messages about the objectives of the project and its societal and economic impact. The tools to be used will include a mix of Web-based communication, press releases, brochures, booklets, multimedia material, etc. With these outputs, the aim is to maximise joint dissemination activities with the initiatives to be supported to maximise the visibility of the project outputs. The dissemination material will be regularly updated to reflect the latest version of the project's status and objectives and written in a way that it is likely to be used also in the outreach activities of the European initiatives the project supports. Electronic and/or paper

versions of HCK will be made available to the Project Officer (beforehand for consultation, and the final published version upon release);

- The project will participate actively in important concertation activities and meetings related to the e-Infrastructures area. The objective is to optimise synergies between projects by providing input and receiving feedback from working groups addressing activities of common interest (e.g. from clusters and projects). Projects may also offer advice and guidance and receive information relating H2020 programme implementation, standardisation, policy and regulatory issues, and relevant initiatives, both international and of EU Member States.

HYEEA services activities

HYEEA SAs aim at providing a number of services that are targeted towards the specific requirements of the European initiatives supported, but that are also – when possible – relevant for profit making entities (especially SMEs), PAs, and researchers. The accessibility and quality of such services will be monitored and assessed throughout the whole project by the different users. The provided services will include the possibility to access in a seamless way the most powerful networking and computing resources available at the European level for research purpose, to access data-storage facilities, to be able to use and chain a large diversity of heterogeneous state-of-the-art models, to take advantage of different and innovative post-processing tools to analyse the simulation results.

In detail, services activities will address all data management activities (WP3), model preparation (WP4), and model execution (WP5) on distributed heterogeneous resources.

Since HYEEA leverages as much as possible the deliverables and best practices of related projects and infrastructure services, HYEEA will not (re)develop basic infrastructure services like authentication, authorization, job scheduling, or core workflow engines. Instead, HYEEA will focus on the integration of these services and on the development (or customization) of existing solutions to the requirements derived from the user scenario of the involved scientific communities of the HYEEA DRM services. The SAs will provide the technical backbone of the HYEEA joint research activities that will be carried out in the framework of the project.

HYEEA joint research activities

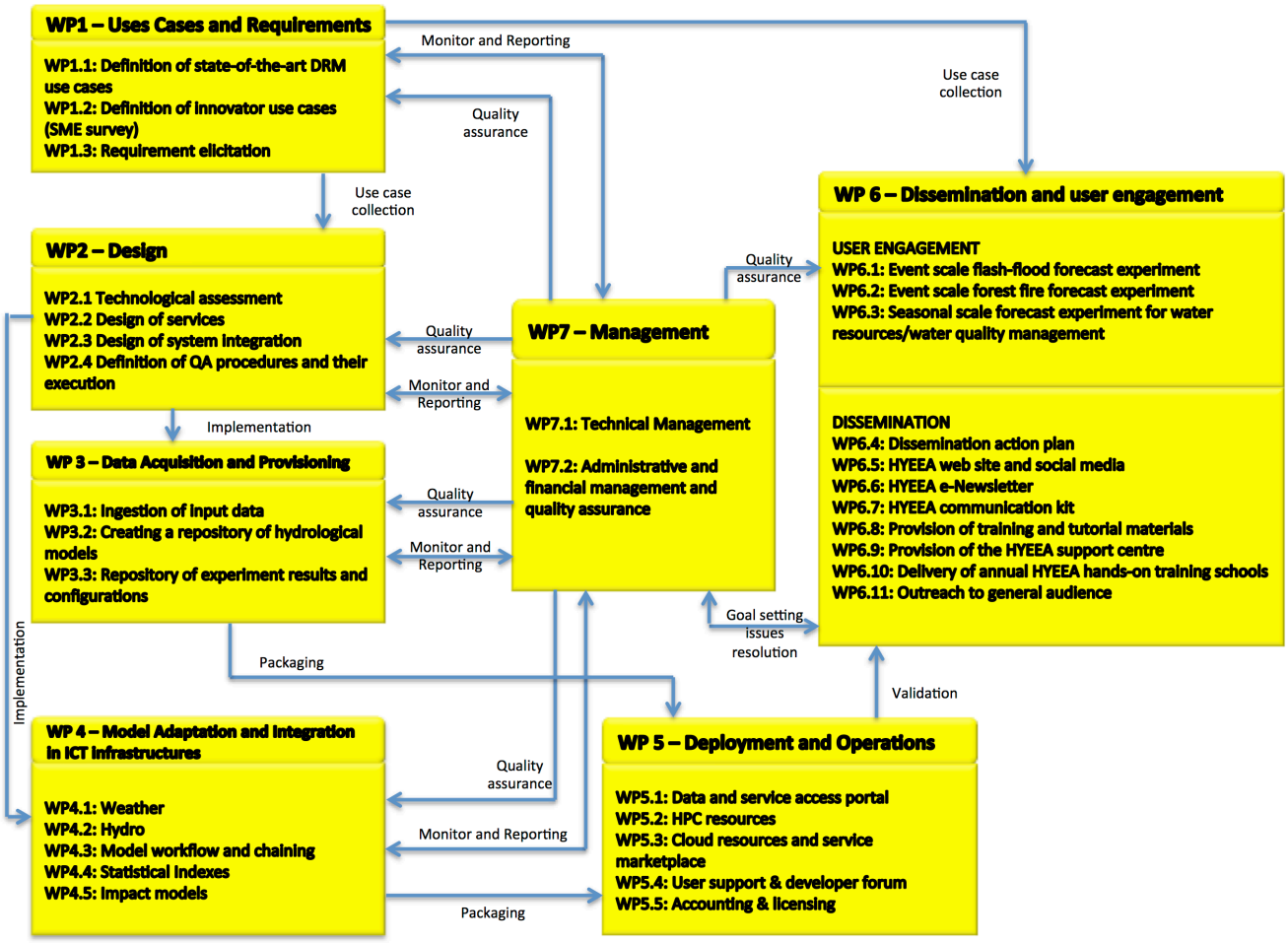
HYEEA JRAs are devoted to the provision of innovative solutions for the natural hazards DRM activities in general. In this respect JRAs are organized in two workpackages.

WP1 will setup a set of DRM use cases based on the specific requirements of the European initiatives supported that will permit to assess the quality of existing services provided by the e-Infrastructure projects and initiatives, and identify gaps where new services or adaptations are necessary. This gap analysis will provide detailed functional and non-functional requirements of the new infrastructure components needed to support DRM activities, we well as their potential impact and benefits for the users. The result will be an eco-system of integrated tools, resources and data within the HYEEA e-Infrastructure. WP2 will take this specification and design the HYEEA e-Infrastructure technological design and implementation plan. It is worthwhile to note that the two JRA workpackages (WP1 and WP2) will constitute the core of the methodology adopted by the project (compare section 1.3 Concept and approach on page 10). The two JRAs will permit to adopt, design and develop innovative services solutions that will allow the DRM community to benefit from computing service in a completely new way. These solutions will thus pave the way towards substantial advances in natural hazards DRM research, as well as operational tools and methodologies that all address the requirements of the initiatives project supports. The challenges addressed by the JRAs will be user driven, but will likely lead to substantial innovations also in in the ICT domain due to the issues that will need to be solved with the existing solutions, allocation policies and technologies that integrate the European e-infrastructures. This corresponds to the expectation that starting from the needs of an actual user community we would be able to go right on the target and provide at the same time results suitable to be generalized and globalized.

3.1 Work plan – Work packages, deliverables, and milestones

In addition to a management work package, the Networking Activities have a strong focus on innovator involvement and support, as well as on dissemination reflecting the desire of the consortium to achieve maximum impact. Attention has been given to the full breadth of potential user communities. The Services Activities are divided into work packages covering data, platform integration, and operation, as well as computation services and the infrastructure behind them, again with deliverables and milestones dovetailing in with the simple reporting structure provided by the management work package. The Joint Research Activities are divided between the design of the HYEEA e-Infrastructure and the user communities requirements collection.

HYEEA PERT



HYEEA GANTT

Workpackages description

Work Package Number	**1**	**Start Date or Start Event:**	**Month 1**
Work Package Title	**Uses Cases and Requirements**		
Activity Type	JRA		

Participant Number	1	2	3	4	5	6	7
Participant Short Name	**CIMA**	LMU	CNR	ECMWF	BSC	TERRA2	ALTA
Person-Months per Participant	**13**	2	3	3	3	3	11

Objectives

This WP provides a set of use cases and validation procedures, in order to guarantee reliable numerical results and compliance with service level agreement (SLA). It aims at creating deep connections with SME/Innovators to collect use cases and support commercial exploitation (i.e. customization and licencing).

Description of Work

Task WP1.1: Definition of state-of-the-art DRM use cases (leader: CIMA)

The task builds an inventory of state-of-the art DRM use cases corresponding to different natural hazards, namely flash-flood, forest fire, and droughts – and response and mitigation approaches of the targeted European initiatives.

The criteria guiding the state-of-the-art use cases identification will be three fold:

- ***Specific gaps identified by the European initiatives*** supported by the project.
- ***EU scientific leading edge*** *in areas where there are emerging solutions that may provide European initiatives additional benefits beyond merely bridging the gaps*, through the interplay and networking with JRC (IAB member), a set of past natural hazards events, producing significant socio-economic impacts, and challenging the predictive ability of the EFAS, EFFIS and EDO services will be identified. The preliminary source of information will be represented by: EFAS bulletins (https://www.efas.eu/efas-bulletins.html), EFFIS annual reports on forest fires in Europe (http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/), and EDO reports of severe drought events (http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1051).
- ***On the national and regional operational leading edge*** *where potential for new synergies exists either through new inter-disciplinary collaborations of through broader geographical coverage of promising services.* The approach requires interplay between different national and regional PAs authorities (e.g. Italian Civil Protection Department, the Italian functional centres network http://www.protezionecivile.gov.it/jcms/en/centri_funzionali.wp?request_locale=en, the Meteorological Service of Catalunya http://www.meteo.cat/) by identifying a set of natural hazards events, producing significant socio-economic impacts, and challenging the national/regional scale predictive ability capacity, also because of limitations in the access to start of the art data and computing intensive services.

Task WP1.2: Definition of innovator use cases (SME survey) (leader: ALTA)

HYEAA R&D activity provides a new and innovative approach, complementary to the traditional operations concept, and demonstrating the benefit of new technologies for large scale processing of EO data, and in-situ data. The Platform will allow both on demand processing for specific user needs and systematic processing to address common information needs of the community as a whole, as well as massive processing on multi-tenant computing resources on the Cloud. Such capacities will address the challenges of accessing to state-of-the-art DRM prediction models and data requires competencies in several fields (Hydrology, Meteorology, Hydraulics, Climatology, Remote Sensing, and Information and Communication Technologies). To exploit the geo-information generated using the Platform it will leverage open APIs for the integration of interactive processing and post-processing services.

The platform is initially intended for research organizations that want the access to the best facilities and instruments to gain a deeper understanding of natural hazards and improve the predictive ability targeting operational activities. Fundamentally the current solution has been designed from working on user requirements from within the consortium. The evolution of the current platform into an

operational service will follow a capacity building process driving the requirements, design and implementation activities.

The HYEAA will follow a model for partnership and community building that is user driven and through the involvement of SMEs with will leverage on new knowledge and know-how, developing and testing new products such as innovative data and models. This process includes a mechanism to gather user needs in liaison with different organisations and obtain industry requirements preferentially from SMEs in the domains of renewable energies, environmental consultants and reinsurance/insurance sectors. This task will survey and establish the community, collect and analyse user and system requirements. The community survey will expose the available capabilities, high level gaps and needs, present and future opportunities, and support the definition of use cases and requirements. It will produce inputs to the preliminary design of the overall infrastructure.

Moreover, it is worth noting that commercial aspects of the platform should also be considered. Indeed, HYEAA will target a large user pool for several SMEs that operate on the business thus fostering the creation of new services and workflows tailored to the community user needs in a way that non-ICT experts will be shielded from the underlying complexities that specific service implementations require. In this sense, the evolution of the HYEAA towards a service marketplace should be properly considered in a sustainability analysis

Task WP1.3: Requirements elicitation (leader: ALTA)

The requirements from the targeted end-users (SMEs, PAs, scientists etc) will be collated during an elicitation process. A questionnaire will be formulated which will ask end-users a variety of questions to ascertain their requirements on a range of topics including the following: 1) their intended purposes for utilising the HYEAA framework, 2) which external datasets/models they require, 3) which datasets/models of their own they would like to use, 4) how frequently they require access to the framework, 5) how they would like their data and results to be stored, visualized and disseminated. From this a report will be compiled which will be used by the subsequent work packages to design, build and modify the HYEAA framework to most suit the needs of the end-users.

Deliverables

The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").

D1.1 Report on definition of state-of-the-art DRM use cases (months 6 (I), 12 (U))
D1.2 Report on definition of state-of-the-art of innovator use cases (months 6 (I), 12 (U))
D1.3 Report on questionnaire results from the requirements elicitation process (months 12)

Milestones

M1.1 First state-of-the-art DRM use cases selected (month 6)
M1.2 First state-of-the-art innovator use cases selected (month 6)
M1.3 Conduct requirement elicitation questionnaire (month 9)

Work Package Number	**2**		**Start Date or Start Event:**			**Month 1**	
Work Package Title	**Design**						
Activity Type	JRA						
Participant Number	1	2	3	4	5	6	7
Participant Short Name	CIMA	LMU	**CNR**	ECMWF	BSC	TERRA2	ALTA
Person-	3	6	**20**	2	10	4	4

Months per Participant							

Objectives

The objective of this Joint Research Activity is to provide the fundamental requirements, an assessment of the state-of-the-art technologies and the initial design for the building blocks and integration services that will be developed and operationally supported by Service Activities (i.e. WP3-5).

Description of Work

Task WP2.1 Technological assessment (leader: IMATI)

This task is finalized to provide an assessment of the available general-purpose e-infrastructure services and technologies plus a comparative analysis of the different approaches underlying current platforms for the study, evaluation and prediction of weather scenarios. The analysis is tailored to provide the background to reuse the best available practices, methodological solutions and to promote multi-domain interoperability experiences.

The following aspects will represent the core of the analysis: technologies for collaborative, extensible environments; data and numerical model integration; e-Infrastructure interoperability.

Task WP2.2 Design of services (leader: BSC)

Based on the requirements analysis (task WP1.3) and the technological assessment (task WP2.1) this task will define the initial design of the building blocs representing the base to support the study, evaluation and prediction of NATURAL HAZARDS and the fast prototyping of innovative services for profit-making users.
It is important to point out that interaction between this WP and the service activities are planned to be continuous and progressive: as soon as a relevant building block/functionality is focused it will be designed and provided to SA. It is expected that some building block/functionality will require an in-deep analysis.

Task WP2.3 Design of system integration (leader: IMATI)

The purpose of this task is to design the integration framework supporting the execution and integration of the services resulting from task 3.3 on production resources. This task aims at designing innovative functionalities based on the advanced technology assessed in task 3.2, with the goal to a) allow seamless access to the underlying basic, general-purpose services and resources and b) to address interoperability between HYEEA and other services through a specific Application Programming Interface (API). The approach in the design of APIs will be incremental.

The API access path will be complemented with a web gateway supporting user interaction with the HYEEA infrastructure

Task WP2.4 Definition of QA procedures and their execution (leader: ECMWF)

Hyeea aims at producing TRL 8 system and services. To guarantee such achievement we plan to validate the simulated results (WP1), and to define QA procedures. Such procedures will include: TRL assessment of the input sources and of exploited computing resources; definition of testing procedures and policies for test execution. In particular we plan to rely on automated unit and functional testing, on a real-time monitoring and reporting facility, and on stress test procedures on the public instance of the infrastructure.

Deliverables

The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").
D2.1 Report on the technological assessment (months 4(I), 18(U)
D2.2 Report on service design (months 8(I), 20(U))
D2.3 Report on system integration (months 10(I), 22(U))
D2.4 Blueprint for standards for QA procedures to assess TRL using an initial-report-stage (marked "I") and one update-stages (marked "U") of this project as hands on case studies, months 14(I), 22(U).

Milestones

M2.1 Architecture blueprint, service design interface and initial definition on HYEEA APIs (12)

M2.2 System integration specification defined (10)

M2.3 Final architecture and APIs (22)

Work Package Number	**3**		**Start Date or Start Event:**			**Month 3**	
Work Package Title	**Data Acquisition and Provisioning**						
Activity Type	SA						
Participant Number	1	2	3	4	5	6	7
Participant Short Name	CIMA	LMU	CNR	**ECMWF**	BSC	TERRA2	ALTA
Person-Months per Participant	7	0	9	**6**	5	12	2

Objectives

The aim of this work package is to ingest the necessary input datasets and hydrological models into the platform and then to visualize the experiment results and store them in a repository. Achieving this will require the development and of pre-existing Application Programming Interfaces (APIs) to ingest data from external sources, it will also require the creation of new repositories built upon the EUDAT solution in order to store both the ingested data and the experiment results. Specifically the objectives can be broken down into four themes:

1. Ingest input data of meteorological forecast and observation data in both gridded and point format
2. Create the repository to store the hydrological models
3. Store both the results and configuration from every model experiment on a repository which can later be queried by users

Description of Work

Task WP3.1 Ingestion of input data (leader: ECMWF)

Each of the ingested input datasets, described below, will be stored in a repository located within the EUDAT system, prior to these the data will be formatted into the M.A.P. standard.

Subtask WP3.1.1 Ingestion of ECMWF forecast data (IS1) – ECMWF

In this task forecast data from the ECMWF and EFAS will be ingested into the forecast data repository. Currently the ECMWF has a python API which can be used to access publically available information. Therefore the specific tasks are:

- Configure the ECMWF API to deliver the necessary forecast data into the repository
- Deliver EFAS forecasts of flash floods and seasonal river flows by adding these data to the existing EFAS WMS-T web service

From this we will deliver a system to ingest ECMWF forecast data built upon the existing python ECMWF API

Subtask WP3.1.2 Ingestion of custom data (IS2) – CIMA

A user may wish to use their own forecast or other input data within their model experiment, therefore an API is required which can ingest these data and store them in a format which can then be used by the computational resources.

- Develop an interface which allows the user to specify their own datasets, this may include their own input datasets to drive a hydrological model or forecasts from their own limited

area model

- M.A.P. the datasets so that they can be used within the computational experiment

Subtask WP3.1.3 Ingestion of observation point data (IS3) – CIMA

Observations of hydro-meteorological parameters including precipitation and river discharge are required as part of procedures such as model calibration and validation. These data are collected on existing platforms such as EFAS-IS and will be ingested from the EU-FLOOD-GIS database using the 2Map python API developed for the JRC MARS unit. We will adapt this to deliver data for the purposes of the HYEAA framework. Additional historical data for the purposes of calibration will be retrieved from other databases including HyMeX and CUAHSI.

Subtask WP3.1.4 Ingestion of gridded observation data (IS4) – TERRA2

Gridded observation data from remote sensing platforms will be ingested into the system. These data will also be used to complement the modelling chain, for example remotely sensed flood extents could be used to identify the affected areas, whilst remotely sensed soil moisture could be used an input into the hydrological model. The development of the ESA-TEP Hydrology platform will give an opportunity to integrate the latest observed data into the modelling framework. Gridded meteorological observations over Europe derived from gauging station networks will be sourced from databases such as E-OBS and EURO4M-APDG. Gridded data of basic hydrological variables such as land cover and soil type will be ingested from the CCM2 project. We will deliver an open source API to ingest gridded remote sensing datasets from the aforementioned portals.

Task WP3.2 Creating a repository of hydrological models (IS5) (leader: CIMA)

The user will have the option of running their experiments with different hydrological models, this task will create the repository to store the required source code and default static input datasets required to run these. The repository will be built upon the EUDAT system with interfaces between the different modelling components in OpenMI Open Interface Standard 2.0 (OGC OpenMI 2.0) using FluidEarth2 implementation.

Task WP3.3: Repository of experiment results and configurations (OS1 and OS2) (leader: IMATI)

As stated above, these repositories will be built upon the pre-existing EUDAT structure. Separate repositories will be created to store the experiment results and the model configurations.

Subtask WP3.3.1: Repository of experiment results – ECMWF

If a user wishes to save the results of their model experiment the results will be stored in the repository. The user will be able to specify whether their results will be publically visible or whether access will be restricted only to themselves.

Subtask WP3.3.2: Repository of experiment configurations –IMATI

In a separate repository the user will be able to store the configurations of the meteorological and hydrological models from their experiments. These can be queried and used at a later date to re-run a model with new forecast data without the need to recalibrate the models.

Deliverables

Each of the following deliverables will also be accompanied by a technical note which will outline the details behind each outcome.

D3.1 Open source APIs to ingest the input data into the HYEAA repositories (month 15):

D3.1.1 Ingest ECMWF forecast data built upon the existing python ECMWF API

D3.1.2 API to ingest gridded remote sensing datasets from portals including ESA TEP-Hydrology

D3.1.3 An API allowing users to ingest their own custom data and models into the system

D3.2 End user focused EFAS, EFFIS, and EDO web services (month 15) to deliver ERIC flash flood warnings and EFFIS and EDO predictions, as well as observational point data

D3.3 HYEEA repositories (month 15) to store the following information:

D3.3.1 Input data from ECMWF and EFAS forecasts, observation data and custom data

D3.3.2 Code, static data and configuration information necessary to run the hydrological models including the default models provided as default as well as custom models provided by the user

D3.3.3 Outputs from simulations performed by the user, these can be stored either in a publically accessible archive or with the option that only that user can access them

Milestones

M3.1 Collect all necessary input data in the correct formats (month 15)

M3.2 Create the repositories of input data and model setups (month 15)
M3.3 Establish APIs to ingest forecast and observed data (month 15)
M3.4 Create the repositories to store simulation results and configurations (month 15)

Work Package Number	**4**		**Start Date or Start Event:**			**Month 3**	
Work Package Title	**Model Adaptation and Integration in ICT infrastructures**						
Activity Type	SA						
Participant Number	1	2	3	4	5	6	7
Participant Short Name	CIMA	LMU	CNR	ECMWF	**BSC**	TERRA2	ALTA
Person-Months per Participant	6	9	9	1	**30**	6	3

Objectives

The aim of this work package is to enable the run of the state-of-the-art model engines for meteorological and hydrological communities. The models will be run using a workflow manager to manage the interaction among the different blocks. The M.A.P. (Metadata, Adaptors, Portability) approach will be adapted to ensure an easy and valid deployment of the services.

This work package will strongly interact with WP5 to deploy and adapt models to the computing services targeted using a dedicated fat node with a custom setup to work these computing services. This will overcome some security requirements from services like PRACE Tier-0 machines (e.g. SuperMUC, and Mare Nostrum HPC facilities).

The set of basic build blocks coupled is:

- **CS1 Deterministic single meteorological model run** – this service allows the run of a single meteorological model with a deterministic configuration, as required for the event scale scenarios;
- **CS2 Ensemble single meteorological model run** – this service allows the run of a single meteorological model with an ensemble configuration;
- **CS3 Deterministic single hydrological model run on a single basin run** – this service allows the run of a single hydrological model on a specific basin with a deterministic configuration;
- **CS4 Deterministic single hydrological model run on a region** – this service allows the run of a single hydrological model on a region, i.e. on an area that may contain more basins thus leading to a multi-basin run, with a deterministic configuration;
- **CS5 Ensemble single hydrological model run on a single basin run** – this service allows the run of a single hydrological model on a specific basin with an ensemble configuration;
- **CS6 Ensemble single hydrological model run on a region** – this service allows the run of a single hydrological model on a region, i.e. a multi-basin run, with an ensemble configuration;
- **CS7 Full hydro-meteorological experiment chain** – this service allows the composition of meteorological and hydrological models in a full chain through the state-of-the-art technology aimed at workflow definition;
- **CS8 Water resources statistical downscaling run** – this service allow the execution of seasonal statistical downscaling services, driven by the ECMWF S4 data, and providing an input for subsequent water resources and water quality applications;
- **CS9 Loss and impact models run –** this service allow the run of RASOR exposure and vulnerability services to drive the RASOR impact modelling services, using input provided by the full hydro-meteorological experiment chain

The user can define any combination of the previous services to perform a given experiment.

Description of Work

The run of the models and the execution of the different indexes will be done using a workflow manager. Based on BSC experience, this tool could be Autosubmit, which is python-based tool to create, manage and monitor experiments by using Computing Clusters, HPC's and Supercomputers. It has support for experiments running in more than one HPC and for different workflow configurations.

For of each computing service definition listed in the tasks, the model will be supplied with according metadata, documentation and licensing, providing methods to translate the inputs and outputs to common standards and ensuring the portability in technical similar infrastructures.

Task WP4.1 Weather (leader: BSC)

In this task, blocks based on weather models will be designed. Deterministic single meteorological model (CS1) and Ensemble single meteorological run (CS2) are targeted for WRF, NMMB/BSC and COSMO models. The user will supply all the configuration parameters in a website or application defined in T5.1. These parameters will be read using an API. The workflow manager will take care of getting all the initial data using ingestion services from WP3 and other files required to run the meteorological models as well as the run of the model itself.

Task WP4.2 Hydro (leader: CIMA)

This task will aim in running the hydrological models. Three different configurations are targeted: deterministic single hydrological model run on a single basin run (CS3), deterministic single hydrological model run on a region (CS4), ensemble single hydrological model run on a single basin run (CS5), and ensemble single hydrological model run on a region (CS6). The workflow manager will take care of getting all the initial data using ingestion services from WP3 and other files required to run the meteorological models as well as the run of the model itself.

Task WP4.3 Model Workflow and Chaining (leader: BSC, IMATI)

Once meteorological and hydrological blocks have been implemented and tested to run stand alone, in this task, we will merge both block to run a full experiment chain (CS7). An experiment can consist in any combination of the computing services described in the WP. The workflow manager will handle the model dependencies and run the blocks on the right time. At the end, the outputs produced will be moved to the repositories provided by T3.3.1.

Task WP4.4: Statistical Indices (leader: BSC)

For each hazard type the raw model output, e.g. river discharge will be converted into a statistical index in order to better convey the level of risk. River discharges will be converted into return periods, flash flood values will be calculated using the ERIC index. For forest fire the Fire Weather Index (FWI) will be used and drought will be communicated by computing the Standardized Precipitation Index (SPI), which is used in the European Drought Observatory (EDO).

Statistical downscaling will be used to downscale seasonal forecast simulations outputs to a fine spatial scale whenever the users require local information (CS8). To facilitate regional and local impact assessments, statistical downscaling techniques, understood as a form of bias adjustment, will be implemented to combine the information of retrospective global seasonal forecast simulations with simultaneous local historical observations and/or reanalyses to infer statistical relationships between the low-resolution seasonal forecast and the high-resolution observations.

Task WP4.5 Impact models (leader: CIMA)

Once the full experiment chain (CS7) has been implemented and tested to run stand alone, this task will be devoted to use the chain predictions (water level, and other hydro-meteorological related fields) as an input for the RASOR services (CS9), accessed through APIs. The workflow manager will take care of getting all the initial data using ingestion services from WP3 and other files required to run the RASOR impact services.

Deliverables

The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").

D4.1 Architecture definition and implementation plan for computing services listed (months 15 (I), 30(U))

D4.2 Prototype of a full experiment chain (month 17)
D4.3 Testing and verification framework (month 30)

Milestones
M4.1 Preliminary delivering of computing services working (month 17).
M4.2 Delivery of all the computing services listed in the WP (month 30).
M4.3 Ensure that the users are able to run a selected computing service (or a combination of them) using the input from the T5.1 (month 30)

Work Package Number	**5**		**Start Date or Start Event:**			**Month 1**	
Work Package Title	**Deployment and Operations**						
Activity Type	**SA**						
Participant Number	1	2	3	4	5	6	7
Participant Short Name	CIMA	LMU	CNR	ECMWF	BSC	**TERRA2**	ALTA
Person-Months per Participant	5	11	10	4.5	11	**21**	5

Objectives

- Focus on the development of Platform instance installation package/procedure, the operation of the main instance of services on the supported computing infrastructures
- Manage the cloud platform and enable the access and deployment of data, processing tools and services. It will use the Developer Cloud Sandbox components developed on previous projects (e.g. G-POD, GEOWOW, SenSyF, Co-ReSyF) to provide the capability to access, process and publish comprehensive multi-source, multi-scale and multi-temporal EO datasets.
- Deploy and operate the cloud infrastructure including the provision of ICT resources

Description of Work

Task WP5.1 Data and Service Access Portal (leader: IMATI)

The goal of this task is the development of the web portal that will provide access to the HYEEA services. It will support model retrieval and configuration, definition of simulations, process monitoring and data access (PI1). While all services will be made available trough APIs, we are also providing an extensible web-based UI that can be used for private, customized instance (PI2). An initial version will be relased at month 18, and the full portal will be available since month 30.

Task WP5.2 HPC resources (leader: LMU)

The goal of this task is to provide consulting in optimizing software, assisting the community in making software scale and as a consequence higher the odds to pass scalability tests in order to get access to HPC-like run-time environments. Computer scientists will function as an enabler through the exchange of information. The goal is to provide support to the HMR community, so that HMR people are able to use their codes on the individual platform. As a consequence, after the project's funding period has ended, HMR people will able to use their codes in HPC environments on their own in order to add to the sustainability of the project results.

Task WP5.3 Cloud resources and service Marketplace (leader: TERRA2)

This task deals with deployment and operations of the cloud infrastructure and the elements of the platform including: cloud orchestration, storage virtualisation, VM provisioning, scaling and cloud bursting. It will operate and manage the infrastructure and support the services work packages performing service integration and deployment on the Cloud Platform. The platform includes a

marketplace that simplifies the deployment of Virtual Appliances and supports their distribution among the community. The marketplace contains metadata that defines the Virtual Appliances and allows discovery through a catalogue service.

The infrastructure management will guarantee the supply of a stable service to the users for the whole duration of the project by defining and organizing the shared cloud computing and local resources used by each service. The operations support will perform problem-solving steps and manage proper involvement of second-level support for issue resolution. It will also handle the different priorities, criticality and timing of multiple daily inquiries. This task will also coordinate areas such as overseeing infrastructure operations, user community support, and contact with technology providers, strategy and policy development, flagship events and dissemination of news and achievements.

Task WP5.4 User Support & developer forum (leader: TERRA2)
This task will provide support to the community and a developer support forum to address user needs and help them to achieve their goals. The developer forum will bind the community and foster a spirit of knowledge sharing. It will be the place to explore the community collective knowledge by searching previous issues and raise new topics. The forum will also allow the task team to address the most common questions in one thread or conversation. The possibility to create new topics and solutions also makes the forum prefereable to FAQ or blog posts that are more difficult to update and maintain. Another task of the forum will be to identify and notice key trends in users behaviour, problems or special concerns that can help to driven the development and improvement of the system. This task will in particular address the following actions:

1. Perform first level maintenance regarding configuration problem solving and problem-solving steps;
2. Track and correct system anomalies detected;
3. Handle the different priorities, criticality and timing of multiple daily inquiries;
4. Manage proper involvement of second-level support for issue resolution;
5. Setup a technical discussion forum.

Task WP5.5 Accounting & Licensing (leader: ECMWF)
Accounting aims to identify how the data are being accessed across the HYEAA system, including which datasets, how often and how they are transferred. For the HYEAA system we will use the EGI Accounting Software, which can identify which respositories are most commonly accessed and how long it takes to access and transfer data. From this potential bottlenecks can be identified and the system can be optimised following the observed usage. Accounting of forecast data from ECMWF will be done using their in-house diagnostics tools which will show how often their data is accessed via the python API and which datasets are most commonly requested.
Much of the data and models that are being used in the HYEAA system are open source and freely available. ECMWF data will be accessed utilising their public licence which grants access to their freely available forecast datasets.

Deliverables
The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").
D5.1 Prototype of data and service access portal (months 18(I), 30(U)
D5.2 HPC resources technical note (months 18(I), 36(U))
D5.3 Report on operations and user support (months 18(I), 36(U))
D5.4 Accounting & licensing technical note (month 18)

Milestones
M5.1 Final Rolout of Support Site (month 6)
M5.2 Working prototype of data and service access portal (month 18)
M5.3 Stable operational level for ICT provision (month 26)

Work Package Number	6		Start Date or Start Event:			Month 1	
Work Package Title	**Dissemination and User Engagement**						
Activity Type	**NA**						
Participant Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Participant Short Name	CIMA	**LMU**	CNR	ECMWF	BSC	TERRA2	ALTA
Person-Months per Participant	18	**24**	5	7	17	4	13

Objectives

Concerning the user engagement, this WP will demonstrate the HYEEA e-Infrastructure functionalities against a strong set of topical research and operational development areas in the field of DRM. These include, but are not restricted to:

Ensemble Driven Workflows: One of the most comprehensive workflows offered by HYEEA e-Infrastructure is the multi-model ensemble prediction system, covering the range of scales from the event to the season with a model chain beginning with meteorology and ending with socio-economic impacts. The approach uses the downstream (flash-floods, forest fires, landslides, and water resources/water management) response to meteorological extremes, including uncertainty ranges, to develop an innovative analysis framework for improved short-term to seasonal predictions that can be further used to support DRM cycle.

***Integrated Modelling*:** Construction and execution of model compositions and chains allowing data to be passed between model instances. For maximum interoperability and extensibility it is essential that a common set of standards be used to achieve this, whether or not each model is implemented as stand-alone or as part of a composition. Applying the standard set around a geo-spatial feature type structure achieves an optimal set, which also facilitates inclusion of observation data from a variety of sources. Integrated modelling compositions can be built using file or memory based transfer of data or a mixture of the two. The standards approach also facilitates the use of post-processing tools for activities such as statistical analysis and *visualization.*

***Innovative software solutions*:** innovative software solutions will be provided for making new DRM user communities, such as socio-economic impact modellers and DRM related environmental and DRM agencies, benefit from computing services offered by global e-Infrastructures such as PRACE, EGI, HELIX-NEBULA

Concerning dissemination activities, this WP will undertake outreach activities to promote the HYEEA innovative services and results produced within the project, as well as on supporting and training HYEEA e-Infrastructure users to access and use it, as well as to contribute to it by adding new applications. Consequently, the main objectives are:

1. to demonstrate the project services to stakeholders (DRM user communities, SMEs, operational centres, the press, and other authorities) ;
2. to raise the project awareness at the European and possibly global level in:
    a. DRM science and operational user communities;
    b. HTC, HPC and cloud computing communities;
    c. Related projects.

The specific means to achieve these objectives are:

3. liaising and partnering with the initiatives supported by the project to encourage them to promote project outputs (e.g. consistently producing material that is suitable for co-promotion of HYEEA and the initiative supported);

4. preparation and distribution of adequate information material including a periodic HYEEA e-Newsletter, media and press releases and promoting them through social media;
5. active participation in conferences and workshops;
6. a web-based support centre, and a series of seasonal training schools;
7. to engage researchers from the whole DRM community (scientists, students, business, administration, civil society) to participate as users of the HYEEA

A proper acknowledgement of the source funding (the H2020 logo and the EU flag, e-Infrastructures logo, etc.) will be included in all dissemination and training activities.

Description of Work

Task WP6.1 Event scale flash-flood forecast experiment (UC1, UC2, UC4) (leader: CIMA)

This task will integrate recent advances in flash-flood predictions to cover the full hydro-meteorological forecasting chain from the weather scenario down to its socio-economic impacts.

The trigger for an event scale hydro-meteorological forecasting experiment will be represented by an EFAS flash-flood alert and the subsequent execution of a hydro-meteorological workflow as described in the user case UC2. These experiments will be executed on a set historical use cases identified in the framework of WP1 activities and they will serve two main categories of users: PAs willing to test the opportunity of migrating their forecasting services on the HYEEA e-Infrastructures for specific regions of interest, using the observational data offered by the HYEEA input data services, and taking into consideration also socio-economic impacts through the user case UC4; researchers willing to push the scientific envelope on gaining a better understanding of the most significant sources of uncertainty in the prediction of flash-flood events; SMEs, possibly belonging to the insurance and reinsurance sectors, willing to assess the possible interplay between severe local hydro-meteorological conditions and specific insured property characteristics and resilience measures, once more building on UC4. Finally also the relevance of the user case UC1 to add new hydrological model engine to the initial (DRIHM based) HYEEA portfolio will be assessed.

Task WP6.2 Event scale forest fire forecast experiment (UC3) (leader: CIMA)

This task will integrate recent advances in forest fire predictions to cover the full forest fire risk.

The trigger for an event scale forest fire forecasting experiment will be represented by an EFFIS alert and the subsequent execution of a workflow as described in the user case UC2. This experiment will be executed on a set historical use cases identified in the framework of WP1 activities and they will serve two main categories of users: PAs willing to test the opportunity of migrating their forest fire forecasting services (built on RISICO model, or Fire Weather Index – FWI) on the HYEEA e-Infrastructures for specific regions of interest, also using the observational data offered by the HYEEA input data services; researchers willing to push the scientific envelope on gaining a better understanding of the most significant sources of uncertainty in the prediction of forest fire events;

Task WP6.3 Seasonal scale forecast experiment for water resources/water quality management (US5, US6, US7, US8) (leader: BSC)

This task will integrate the recent advances in climate prediction to provide atmospheric indicators known to affect water management (for instance, predictions of precipitation extremes relevant for the sector such as the percentiles 10 and 90 over the growing season), large-scale indices that allow to build stories explaining the reasons behind what could happen in the next few months and an assessment of the influence of short-term climate change, all from seasonal predictions. Climate forecast systems are affected by biases, in this sense, a range of bias-correction methods will be applied to obtain similar statistical properties as found in the observed variables. Statistical downscaling, understood as a form of bias adjustment, will be used whenever the users require local information. Model results will be evaluated against observational data sets, provided by ESA-TEP hydrology and other available observational hydro-meteorological datasets, and a number of reanalyses and observational gridded datasets. Uncertainty estimates and reliability will be estimated using ensemble prediction standard methodologies to contribute to the interpretation of the robustness of the climate information, a key element in any decision-making process.

This experiment will be executed on a set historical use cases identified in the framework of WP1 activities and they will serve two main categories of users: PAs willing to test the opportunity of migrating their water resources/water quality services on the HYEEA e-Infrastructures for specific regions of interest, also using the observational data offered by the HYEEA input data services; researchers willing to push the scientific envelope on gaining a better understanding of the most significant sources of uncertainty in the seasonal prediction of water resources/water quality.

The model chain defined in this task (UC7, UC8) will be implemented for two periods of study (identified in WP1):

- Past event. The model chain will be implemented and evaluated in a hindcast mode. (first set of services at M18).
- Near real-time forecast. A specific exercise in a forecast mode will be performed to demonstrate TRL8 services (e.g. winter or summer 2018) (M30).

Then the hydrological/water resources models will be initialized from the seasonal forecast data to obtain an ensemble of hydrological/water resources predictions, out of the different ensemble members. The results will be applied to demonstrate water resources/water quality management that can take mitigate drought impacts.

Task WP6.4 Dissemination action plan (leader: LMU)

This task is aiming at the direction and management of all dissemination activities of the project. The objective is therefore the preparation of a detailed plan for the use and dissemination of foreground in which all dissemination actions are described. The action plan also contains for each task a success definition and a related measurement specification.

The key step in forming of the dissemination plan is to analyse the communication needs, styles and channels of the initiatives project supports and to create a plan that maximises the ease HYEEA material can be used by the supported initiatives. The analysis is condensed into a dissemination toolkit that includes:

- Style guide that e.g. support co-branding of the outreach material with logos of the project and the participating European initiatives.
- A library of initiative descriptions that can be used to build press-releases and web-based marketing material
- List of social media channels (especially Facebook & Twitter) to refer to in different types of announcements
- Requirement analysis of the project website and social media channels

The dissemination action covers also activities aimed at the general public and, in particular, for awareness-raising and educational purposes. It will therefore consider how best to convey messages about the objectives of the project and its societal and economic impact, leveraging as much as possible material from the European initiatives supported. The tools considered will include Web-based communication, press releases, brochures, booklets, multimedia material, etc to be realised by HYEEA Communication Kit (HCK) task WP6.7. An important role of the HYEEA dissemination plan will be assumed by the HYEEA community manager focusing on cultivating relationship with the different project stakeholders, namely research and operational institutions, industry/SMEs, funders, and citizens.

Task WP6.5 HYEEA web site and social media (leader: LMU)

The Internet platform will allow free access to technical project material as well as to project archives. As the goal of the project is to leverage dissemination channels of the European initiatives, the dedicated project website will aim at using standard CMS components and social media services with relatively minor adaptations in order to launch them at the earliest stage of the project possible (ideally before the kick-off). This approach will also lower the maintenance effort needed, making it easier to maintain online presence also after the project. Conceptually the web site will consist of three areas with the following restrictions:

1. A public area for disseminating the project's purpose;
2. A semi-public area for describing how to use the deployed HYEEA services;
3. A private area, which is readable and writable by project partners only. It will serve as a communication and collaboration medium and will contain all work in progress, such as deliverable drafts, technical annexes, internal notes, and so on.

The semi-public area may also be hosted on relevant services of one or more of the European initiatives supported, in which case the dedicated project website will maintain list of links to these sources (and an automatically updated digest of the latest changes in them, if these external fora support the necessary functionality). This task also incorporates all maintenance activities over the course of the project and planning of the post-project online presence.

Task WP6.6 HYEEA e-Newsletter (leader: CIMA)

For external communication a periodic HYEEA e-Newsletter will be prepared and publicized

electronically. The e-Newsletter can be downloaded by the general public from the public web site upon registration. It will be advertised at various forums.

Task WP6.7 HYEEA Communication Kit (leader: LMU)

For public relations, a HYEEA Communication Kit (HCK) will be prepared using the tools developed in task WP6.4.. The kit can be distributed at conferences, seminars, workshops, and other occasion where a give-away is important. The kit may consist of the printed version of the most recent HYEEA e-Newsletter, dedicated leaflets, white papers, a project poster and selected electronic media (e.g. Live USB sticks with HYEEA information) and other promotional material (e.g., ballpoint pens). The leaflets will contain information similar to a brief summary of the public portion of the web site in a quality layout. It will advise and inform the stakeholders of the existence of the HYEEA as well as of its goals and achievements. The poster will showcase the project at specific locations. The kit also serves as input for task WP2.5 as it can be used as press kit. A first version of HCK will be available in its basic version at the beginning of the project and will be revised periodically. The HCK will be regularly updated to reflect the latest version of the project's status and objectives. Electronic and/or paper versions of HCK will be made available to the Project Officer (beforehand for consultation, and the final version upon release).

Task WP6.8 Provision of training and tutorial materials (leader: ECMWF)

This task will aim at providing HYEEA tutorials, training materials and archives, including codes, slides, videos, and evaluations, to be used for the support centre and for seasonal schools.

The training material will include information on how to use the by then existing HYEEA environment and components as well as documentation on how to contribute new models to the HYEEA environment. A procedure of evaluation of tutorials and training material will be carried on in order to improve them.

Task WP6.9 Provision of the HYEEA support centre (leader: BSC)

This task will aim at setting up and operating a web-based support centre to provide assistance on how to use the by then existing HYEEA environment and components and on how to contribute additional data and models to the HYEEA environment. Assistance will be provided by making all the training material available on a special section of the HYEEA web site. It will be ensured that those seeking training or support for HYEEA, either for a group or as an individual, can obtain information quickly and easily in the support centre.

The support centre will offer an on demand web-based consultation service for anyone seeking special support beyond the training materials. The support centre will contain an Evaluation and Quality Control (EQC) system.

Task WP6.10 Delivery of Annual HYEEA Hands-On training Schools (leader: ECMWF)

This task is dedicated to the familiarization of all interested end-users and stakeholders with the HYEEA e-Infrastructure. During a series of hands-on seasonal schools, the participants will learn how to use the HYEEA infrastructure, how to benefit from it, and how to develop applications for it. The schools will be offered on an annual basis.

Task WP6.11 Outreach to general audience (leader: CIMA)

This task will include the participation of all the partners in outreach activities (and promotion) to increase the knowledge about the HYEEA project services and the use of these technologies, addressed to a non-expert audience. The task will collect statistics of outreach events and media (e.g. conference talks with participant numbers, media stories and their audience sizes), website and social media statistics, success stories etc. Using this data the task will identify gaps e.g. in the available material that should be addressed in order to maximise impact. Besides the use of the tools developed in the other tasks, it will create a glossary about the terms used in the project related to e-infrastructures and natural hazards and a language more easy to understand by a broad audience. This task will also include the engagement of citizens in the project, development of activities (on line and off line) and materials to encourage the amateurs' participation as a Citizen Science contributors and users of the projects as well as non technical agents (including policy makers).

Deliverables

The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").

D6.1 Event scale flash-flood forecast experiment use cases demonstrated (first set of services

validated at month 18, second at month 30, final TRL8 services at month 36)
D6.2 Event scale forest fire forecast experiment use cases demonstrated(first set of services validated at month 18, second at month 30, final TRL8 services at month 36)
D6.3 Seasonal scale forecast experiments for water resources/water quality management use cases demonstrated(first set of services validated at month 12, second at month 30, final TRL8 services at month 36)
D6.4 Final Plan for the Use and Dissemination of Foreground (month 6)
D6.5 HYEEA web site and social media accounts(month 6)
D6.6 HYEEA e-Newsletter (months 6, 12, 18, 24, 30, 36)
D6.7 First version and revisions of HCK (months 6 (I), 12 (U), 18 (U), 24 (U), 30 (U), 36 (U))
D6.8 Dissemination report (months 12 (I), 24 (U), 36 (U))
D6.9 Provision of HYEEA support centre, including training and tutorial materials (months 18(I), 36 (U))
D6.10 HYEEA annual hands-on training schools (months 24, 36)
D6.11 Glossary and pedagogic material (month 24)

Milestones
M6.1 First set of services for event scale flash-flood forecast experiment use cases (month 18)
M6.2 First set of services for event scale forest fire forecast experiment use cases (month 18)
M6.3 First set of services for seasonal scale forecast experiments for water resources/water quality management use cases (month 18)
M6.4 Release of dissemination action plan (month 6)
M6.5 HYEEA web site on line and social media accounts active (month 6)
M6.6 First e-Newsletter available (month 6)
M6.7 First HCK release (month 6)
M6.8 First dissemination report release (month 12)
M6.9 First release of support centre available on HYEEA web site (month 18)
M6.10 First HYEEA training school organized (month 24)
M6.11 Glossary publication (month 24)

Work Package Number	**7**		**Start Date or Start Event:**			**Month 1**	
Work Package Title	**Management**						
Activity Type	**MGT**						
Participant Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Participant Short Name	**CIMA**	LMU	CNR	ECMWF	BSC	TERRA2	ALTA
Person-Months per Participant	**33**	1	1	1	1	1	1

Objectives
This WP will address the coordination, financial and administrative management of HYEEA. The main objective of this WP is to manage efficiently all project activities, including the communication between the partners and with the European Commission (EC), the co-ordination of actions for performing the workplan and the monitoring of activities and resources for the full duration of the project to avoid any deviation between planned activities and actual work.

Description of Work
WP7 deals with both the administrative and the financial management as well as with the HYEEA quality assurance. Efficient management procedures and managerial bodies will be established (as

described in section 3.2) for ensuring an effective and successful work of the project as a whole. Other work package objectives relate to the monitoring of the overall project progress and the quality of results, the coordination of work- and information-flow between activities and the organization of the kick-off meeting, the periodical internal meetings, and the cooperation with the European Commission services.

Task WP7.1 Technical Management (leader: CIMA)

This task is aiming at the management of the technical activities of the project. The managerial structure will involve the Steering Committee (SC) composed of and lead by the Project Director (PD) and appointed representatives of each project partner, and the Work Packages Leaders (WPLs), and the Project Office (PO).

Task objectives include the coordination of work- and information-flow between activities, the monitoring the overall progress of the project, as well as establishing the procedures for ensuring high quality of the project outcome.

The activity of this task will be devoted to the organization and management of partner meetings.

Task WP7.2 Administrative and financial management and quality assurance (leader: CIMA)

This task will be carried out by the PO and provides the necessary administrative support for the project in general and the PD in particular. 61 twill encompass the management of the consortium's financial resources including the distribution of funding, the co-operation with the EC on contractual and financial matters, the monitoring of resource usage and contractual terms and other strictly administrative tasks.

CIMA will take care of the preparation and timely delivery of the different periodic reports to the EC. The activity of this task will also include communication with the EC and partners and distribution of periodic financial reports. In this task, an appropriate quality control on the project deliverables including formal internal review process will be implemented and performed. All reports will be delivered in two stages: an initial-report-stage (marked "I") and one or more update-stages (marked "U").

Deliverables

The following deliverables will be prepared during the course of the project. It is assumed that the task/subtask leaders drive the delivery while the other partners support the process by providing contents and other material. Some deliverables will be delivered in two stages: an initial-stage version (marked "I") and one or more update-stages (marked "U").

D7.1 Quality assurance plan and risk assessment (month 2)

D7.2 Minute of periodic partners meetings (months 6 (I), 12 (U), 18 (U), 24 (U), 30 (U), 36 (U)) including a version of the HYEEA data management plan (DMP) approved by partners (to be published as a separate deliverable D7.2a HYEEA data management plan with similar update schedule (every 6 months) in case the project is chosen as a participant in the Open Research Data Pilot)

D7.3 Periodic activity report (months 13 (I), 25 (U), 36 (U))

D7.4 Periodic financial report (months 13 (I), 25 (U), 36 (U))

Milestones

M7.1 Kick-off meeting (month 1)

M7.2 Annual partners meetings (months 12, 24, 30)

M7.3 Final meeting (month 36)

Table 3.1b: List of work packages

Work package No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End Month
WP1	Uses Cases and Requirements	1	CIMA	38	1	12
WP2	Design	3	CNR	49	1	22
WP3	Data Acquisition and Provisioning	4	ECMWF	41	3	15
WP4	Model Adaptation and Integration in ICT infrastructures	5	BSC	64	3	30
WP5	Deployment and Operations	6	TERRA2	67.5	1	36
WP6	Dissemination and user engagement	2	LMU	88	1	36
WP7	Management	1	CIMA	39	1	36
			Total Months	386.5		

Table 3.1c: List of Deliverables

Deliv. number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
D7.1	Quality assurance plan and risk assessment	7	CIMA	R	PO	2
D2.1	Report on the technological assessment	2	IMATI	R	CO	4
D1.1	Report on definition of state-of-the-art DRM use cases	1	CIMA	R	CO	6
D1.2	Report on definition of state-of-the-art of innovator use cases	1	ALTA	R	CO	6
D6.4	Final Plan for the Use and Dissemination of Foreground	6	LMU	R	PO	6
D6.5	HYEEA web site and social media accounts	6	LMU	OTHER	PU	6
D6.6	HYEEA e-Newsletter	6	CIMA	R	PU	6
D6.7	First version of HCK	6	LMU	OTHER	PU	6
D7.2	Minute of periodic partners meetings	7	CIMA	R	PO	6
D7.2a	HYEEA data management plan	7	CIMA	R	CO	6
D2.2	Report on service design	2	BSC	R	CO	8
D2.3	Report on system integration	2	IMATI	R	CO	10
D1.3	Report on questionnaire results from the requirements elicitation process	1	ECMWF	R	CO	12
D6.8	Dissemination report	6	LMU	R	PU	12
D7.3	Periodic activity report	7	CIMA	R	PO	13
D7.4	Periodic financial report	7	CIMA	R	PO	13
D2.4	Blueprint for standards	2	ECMWF	R	CO	14
D3.1	Ingestion of Input Data	3	ECMWF	DEM	PU	15
D3.2	End user focused EFAS,	3	ECMWF	DEM	PU	15

	EFFIS, and EDO web services					
D3.3	HYEEA Repositories	3	IMATI	DEM	PU	15
D4.1	Architecture definition and implementation plan for computing services listed	4	BSC	R	PO	15
D4.2	Prototype of a full experiment chain	4	BSC	DEM	PU	17
D5.1	Prototype of data and service access portal	5	IMATI	DEM	PU	18
D5.2	HPC resources technical note	5	LMU	R	PO	18
D5.3	Report on operations and user support	5	TERRA2	R	PO	18
D5.4	Accounting & Licensing Technical Note	5	ECMWF	R	PO	18
D6.1	Event scale flash-flood forecast experiment use cases demonstrated	6	CIMA	DEM	PU	18
D6.2	Event scale forest fire forecast experiment use cases demonstrated	6	CIMA	DEM	PU	18
D6.3	Seasonal scale forecast experiments for water resources/water quality management use cases demonstrated	6	BSC	DEM	PU	18
D6.9	Provision of HYEEA support centre, including training and tutorial materials	6	LMU	OTHER	PU	18
D6.10	HYEEA annual hands-on training schools	6	ECMWF	OTHER	PU	24
D6.11	Glossary and pedagogic material	6	CIMA	OTHER	PU	24
D4.3	Testing and verification framework	4	CIMA	DEM	PU	30

3.2 Management structure and procedures

3.2.1 Organisational structure and decision-making mechanisms

The main goal of any good project management is to guarantee that the project goals will be achieved efficiently and effectively. The project management architecture here adopted is adapted to the specific needs of the project and the size of the consortium. It defines a reliable and efficient structure including a set of procedures, which are auxiliary but important and indispensable for ensuring effective and successful execution of the project and subsequent production of results. This goal is achieved by establishing efficient management procedures for two managerial aspects: administrative and financial management as well as operational management together with quality assurance. Corresponding mechanisms will be formulated to take decisions affecting the project's outcome as well as for the administrative and operational coordination of the project. Further, the project management establishes the means of communication within and outside the project, and represents the sole interface to the EC. Owing to the size of the consortium a relatively simple managerial structure for project is proposed, consisting of the following core bodies (Figure 8): Steering committee (SC), Project Director (PD), Work Packages Leaders (WPLs), Project Office (PO), and International Advisory Board (IAB).

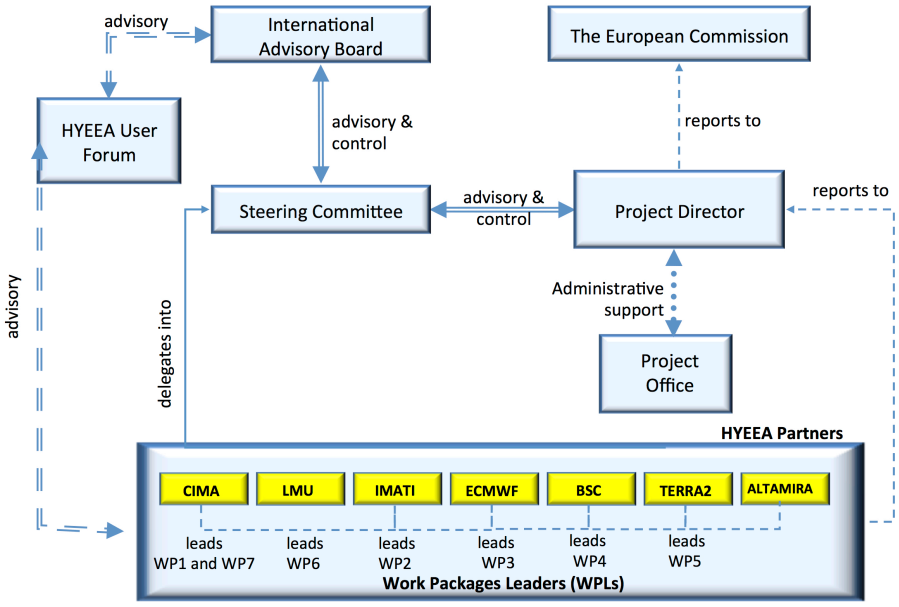


Figure 8: HYEEA organisational structure and decision-making mechanisms.

The **Steering Committee (SC)** is the highest authority of the consortium with ultimate responsibility for all aspects of the project. It will be instantiated at the start of the project and consists of appointed representative from each consortium member with one vote per partner. The SC is chaired by the Project Director (PD) who also leads work package NA1. The SC is the only managerial body that can approve major changes in the project plans, if required for successful accomplishment of project objectives, including changes to partner budgets as well as termination and addition of partners. The SC responsibility encompasses monitoring of the overall project progress as well as reviewing and approving project deliverables and administrative and managerial reports before submission to the EC. In order to ensure a sufficient degree of information flow between SC members, periodic meetings (in person or if possible via teleconference) will be organized. The SC is also in charge of approving the access of external users to the HYEEA e-Infrastructure based on requests by the PD.

The **Project Director (PD)**, Dr. Antonio Parodi, appointed by and representing the coordinating partner (CIMA) leads WP1. The PD's responsibility with respect to administrative and financial management of the project includes the following tasks: management of the consortium's financial resources including funds distribution; constant monitoring of resource usage and contractual terms; organization of project internal meetings and external/internal reviews; cooperation and consultation with the EC on contractual and financial matters; ensuring that legal and ethical issues are properly dealt with; and other strictly administrative activities.

In addition, the PD is responsible for the coordination of the Work Package Leaders (WPLs), ensuring that the project schedule as a whole is upheld, the individual Work Packages (WP) work in a cooperative way to achieve the project objectives and to ensure the project deliverables are consistent and do not contradict each other. The PD shall also be responsible for maintaining the overall project schedule, ensuring its consistency across the individual WP. Based on the input from the WPLs, the PD may recommend and request changes in the project plan (if necessary) to the SC, respond to any situations that may represent a threat to the project success, recommend the solutions for problem solving, identify measurable success indicators for all activities, and define the structure of deliverables and the preparation of final project reports.

Additionally, the direction and coordination of the operational activities within the project, which are essential for the project's success, will be in charge of the PD. This activity includes the management and coordination of work and information flow among different WPs and activities, as well as monitoring of the project's progress with respect to project schedules in terms of milestones and deliverables. Operational management is also in charge of the organization of periodical project internal meetings, and the provisioning of the tools used for the project's internal operations. This includes a project management portal, which provides a collaborative

working environment, including mailing lists and archives, workflow and document management tools, and other administrative tools. This part is in charge of HYEEA that will setup a web site for both dissemination and management purposes. Another important issue for efficient collaboration between partners is the arbitration of arising conflicts (if any). The PD is supported for all administrative tasks by the **Project Office (PO)**, which is appointed by the coordinating partner and performs strictly administrative support functions.
The **Work Packages Leaders (WPLs)** perform the primary role in ensuring the efficient collaboration between the partners within each work package. Their responsibility includes successful execution of work package tasks, reporting to the PD and providing the PD with detailed plans for the work package, implementation of plans approved by the SC, monitoring progress within each activity, and supervision of the preparation of deliverables and final reports. A further important task of the WPLs is the arbitration of arising local conflicts (if any). In addition, WPLs may request changes of activity schedules or objectives if this is necessary for successful project execution. All WPLs are represented in the SC through their corresponding institution.
The **International Advisory Board (IAB)** elects a chairperson, who is invited to the SC meetings as an observer. The IAB advises the SC in strategic affairs concerning the project objectives. The members of the IAB are handpicked from acknowledged experts in the field. In order to steer the project as efficiently and as effectively as possible, the IAB will advise the SC and rather than the PD directly. **Delegates from the Joint Research Center**, **European Cluster Observatory, European Institute of Innovation & Technology, Italian Civil Protection Department, and from various regional hydro-meteorological public administrations will be invited to join the HYEAA IAB.**

3.2.2 Quality assurance

The operational coordination also defines quality standards for the output of the project. The quality assurance process includes a cyclical process for checking all deliverables, i.e. results of the project. These results include:

- periodic activity and management reports, and the final report of activities from NA1;
- technical reports (deliverables);
- dissemination and training results from WPHYEEA;
- contributions to other relevant parties, e.g. e-IRG (www.e-irg.eu/);
- information available on the project web site (www.hyeea.eu);
- brochures and presentations at general conferences, exhibitions, workshops and other meetings of relevant parties.

As this project is relatively small, an appropriate quality assurance has to be defined without increasing substantial management overheads, while at the same time maintaining the required level of quality. The approval of final results is confirmed by the PD, once initial approval has been given by the WPL. The WPL continuously checks the results of the corresponding WP. Each deliverable will be checked by an independent group of experts before being released. Due to financial limitations, we propose that this group of independent experts consists from partners from the project consortium, not directly engaged in the development process. Quality checking and cross-reading is a process which helps the WPL to release the deliverable. If necessary, any deliverable can be returned and postponed to the WP for further improvements. Contribution to other relevant parties, joint publications, and information available on the web site will be sent for comments and approval to the SC.

3.2.3 Conflict management and problem escalation

A procedure for conflict management is implemented as guidance for the SA. The responsibility for conflict management lies with the PD. The PD establishes responsibility for conflict management by explicitly taking charge of resolving/managing the conflict. However, it is the responsibility of all partners to report to the PD any identified issues as soon as possible, preferably before the development of conflicts. Conflict management strategy:

The project's conflict management strategy is achieved through these three key goals:

A. Discover and resolve issues before they become serious conflicts;
B. Create a climate of trust where partners feel free to exchange any ideas;
C. Encourage and engage partners to speak out their minds and without hidden agendas

The three key activities are as follows:

1. Review the current project progress at periodical meetings to be able to detect any possible problems before they arise;
2. Create a list of activities (list of issues to be solved) where project issues are captured and their status (open, under investigation, deferred, fixed etc) is remembered;
3. Monitor issues through an issue management process, consisting of: detection, recording, analysing, prioritising and allocating ownership of issues.

The following problem escalation path (to be solved on the lowest level, if possible) is defined:
WP Partner ➔ WP Leader ➔ Project Director ➔ Steering Committee

A Consortium Agreement (CA) will define the rights and duties of partners, PD, PO, and SC in case of conflict announcing, management and solving. The project managerial bodies will be established before the kick-off of the project and accepted by the SC during the first project meeting. The initial project meeting will be used to refine the cooperation rules and the adjustment of activity scheduling or objectives. The organisation of regular internal meetings is also planned for overall progress assessment and discussion of changes in the activity time-plan or goals (if necessary, for successful project execution). The managerial bodies will be continuously active during the whole project lifetime, preparing activity and managerial reports, providing administrative support for the project, monitoring the overall progress of the project and quality of results, coordinating the work and information flow among the WPs, interfacing with the EC and solving arising local conflicts (if any).

Table 3.2a: List of Milestones

Milestone number	Milestone name	Related work package(s)	Estimated date	Means of verification
M7.1	Kick-off meeting	WP7	1	Minutes of the kick-off meeting
M1.1	First state-of-the-art DRM use cases selected	WP1	6	Report available
M1.2	First state-of-the-art innovator use cases selected	WP1	6	Report available
M5.1	Final Rolout of Support Site	WP5	6	Support website is accessible and developers are able to register and post issues
M6.4	Release of Dissemination Action Plan	WP6	6	Report available
M6.5	HYEEA web site on line and social media accounts active	WP6	6	Website accessible, social media working
M6.6	First e-Newsletter available	WP6	6	e-Newsletter link disseminated
M6.7	First HCK release	WP6	6	HCK disseminated
M1.3	Conduct requirement elicitation questionnaire	WP1	9	Questionnaires collected
M2.2	System integration specification defined	WP2	10	Report available
M2.1	Architecture blueprint, service design interface and initial definition on HYEEA APIs	WP2	12	Report available
M6.8	First dissemination report	WP6	12	Report available
M7.2	Annual partners meetings	WP7	12, 24, 30	Minutes of the annual

				partners meetings
M3.1	Collect all necessary input data in the correct formats	WP3	15	Open source system validated
M3.2	Create the repositories of input data and model setups	WP3	15	Repositories validated
M3.3	Establish APIs to ingest forecast and observed data	WP3	15	APIs validated
M3.4	Create the repositories to store simulation results and configurations	WP3	15	Repositories Validated
M4.1	Partial delivering of computing services working	WP4	17	Computing services validated
M5.2	Working prototype of data and service access portal	WP5	18	Data and Service Portal is accessible and populated with initial dataset and services
M6.1	First set of services for event scale flash-flood forecast experiment use cases	WP6	18	Validated by user group
M6.2	First set of services for event scale forest fire forecast experiment use cases	WP6	18	Validated by user group
M6.3	First set of services for seasonal scale forecast experiments for water resources/water quality management use cases	WP6	18	Validated by user group
M6.9	First release of support centre available on HYEEA web site	WP6	18	Support centre online
M2.3	Final architecture and APIs	WP2	22	Report available
M6.10	First HYEEA training school organized	WP6	24	Report on Seasonal School
M6.11	Glossary publication	WP6	24	Glossary available on the website
M5.3	Stable operational level for ICT provision	WP5	26	Demonstration that a services is able to provision ICT resources
M4.2	Delivery of all the computing services listed in the WP	WP4	30	Computing services validated
M4.3	Ensure that the users are able to run a selected computing service (or a combination of them) using the input from the T5.1	WP4	30	Validated by user group
M7.3	Final meeting	WP7	36	Minutes of the final meeting

Table 3.2b: Critical risks for implementation

Description of risk	WPs involved	Proposed risk-mitigation measures
Inadequate effort of one or more of the partners to the required quality of work	WP7	All the problems relevant to any potential contingency arising among the partners will be addressed in the Consortium Agreement
The participation of interested stakeholders to the winter/summer HYEEA schools	WP6	The pre-existent scientific connections of HYEEA partners allow to increase the usage of the support center and to involve a suitable number of stakeholders

and workshops is low		in the HYEEA schools. Furthermore, the Coordinating partner could eventually propose grants to cover participation expenses for students or invite keynote speakers
The web site is on-line, but nobody visits it	WP6	A link to the HYEEA web site is inserted into the web sites of the partners and suitably highlighted. The circulation of mailing lists, the use of a common template for all of the documents (coordinated public image of the project) and the adoption of Search Engine Optimization techniques, will enhance the project web site positioning
The HYEEA management structure is not effective	WP7	The HYEEA management structure is designed according to the standard for analogous e-Infrastructure projects
Dissemination and user engagement/outreach activities are not effective	WP6	The supported European initiatives and e-Infrastructure providers will be consulted in order to find out what kind of material they would be willing to pass on through their own network. In parallel to this survey, sponsored social media updates may be considered as a stop-gap measure to increase awareness among the general public, and opportunities for elevator pitches and invited talks in the relevant events are investigated as means to increase awareness among the DRM and e-Infrastructure community.
The project fails to deploy the HYEEA e-Infrastructure. The ICT and natural hazards DRM resources and services are not collected from HYEEA partners thus a common blueprint is not endorsed by a majority and the HYEEA e-Infrastructure cannot be deployed	WP3, WP4 and WP5	This high-level project risk is mitigated by the institution of a management structure coordinating the work and ensuring the proper information flow between the work packages inside the project and interested parties outside. Regular activity and management reports to the Steering Committee ensure proper monitoring of progress. Furthermore, the ICT participants have long-standing experience working on national ICT initiatives and current efforts, such as EGI, PRACE, HELIX NEBULA, EUDAT or using the Grid and HPC facilities as members of virtual organizations. Along the same lines HYEEA partners have a relevant experience in top-level natural hazards related projects as HyMex, MEDEX, MAP D-PHASE and many others
Divergences between user requirements and services design and provisioning	WP1, WP2	HYEEA partners will discuss and share user requirements definition, so the divergence between requirements from the various JRAs will be detected in an early moment and minimized. Furthermore, those requirements will be the subject of Project Deliverables and documents must be ready and agreed before sending financial statements to the EU
Insufficient computing and storage resources are available	WP2 WP5	If ICT requirements for HYEEA activities are highest than planned, ICT partners will manage accesses to additional resources. If the adding of these resources is not enough, a priority list of jobs and result storage will be defined
Delays in model and/or data provisioning by partners	WP4 and WP5	The implementation of models and algorithms to be will be monitored through the HYEEA management structure (executive management) so that delays and critical issues in the implementation process will be detected in an early moment, reduced and solved
Insufficient performances are	WP4 and	If the computing performances will be considered too

obtained for HTC and HPC activities	WP5	low compared with user expectations, advanced scheduling solutions for computing jobs can be adopted. The nature of the user services (web based access, composition of services into workflow) will allow for the definition of an architecture that will be quite independent with respect to the underlying hardware resource providerThis is a major benefit from the HYEEA e-Infrastructure that provides flexibility and ease of scalability
Delays in enabling the SAs activities on models/data	WP3, WP4, WP5	Modular step-by-step implementation. Those features are activated, which are accepted and agreed upon
Delays/problems in models execution through the HYEEA e-Infrastructure.	WP6	Partners contributing to WP6 will execute their models locally according to user requests and will made available only data outputs through the HYEEA e-Infrastructure

3.3 Consortium as a whole

The HYEEA consortium gathers internationally distinguished researchers and Institutions in the field of natural hazards DRM and ICT technologies able to provide an interdisciplinary and comprehensive contribution to accomplish the key objectives of the project. The consortium is HMR driven aiming but well balanced in terms of roles, expertises, and competences: 5 DRM oriented Institutions (CIMA, ECMWF, BSC, TERRADUE, ALTAMIRA) and 3 ICT Institutions (LMU, CNR-IMATI, BSC). The HYEEA consortium involves partners which provide know-how in basic and applied research activities concerning the development and usage of natural hazards modelling engines, model and data coupling standards (such as netcdf-CF, waterML, and OpenMI), flood, wildland fire, and droughts events prediction systems, water resources availability and quality assessment, environmental impact assessment and disaster risk reduction activities and the preservation of terrestrial and water-related ecosystems (as testified by the participation to projects as DRIHM, ESA-TEP, RASOR, and other). The HYEEA consortium involves partners who directly advise public authorities or have delegated policy mandate in their countries; furthermore, the consortium has numerous links to flood forecasting centres in Europe and the rest of the world. ICT partners provide to the consortium a profound know-how in managing HPC, HTC, and cloud computing systems based on the experience from several years of network and system management and from participation to several national and international ICT projects as: PRACE, EGI, EUDAT, HELIX-NEBULA, and GEANT. Some ICT partners (e.g., LMU) also participate in standardization bodies like OGF-Europe. The consortium will benefit from these experiences when accomplishing the objectives of the project. In particular, the collaboration between natural hazards DRM and ICT institutes within the HYEEA consortium will lead to cross-fertilization and the deployment of an HYEEA e-Infrastructure that will enable a new way of tackling the DRM cycle of natural hazards from their onset to the subsequent social/economic/environmental impacts at European and possible global levels. The consortium involves several university departments and independent research centres having different links with universities. This increases the diversity of research environments, along with opportunities to disseminate and cross-fertilize the knowledge between the natural hazards DRM component and the ICT component, and to translate it into university curricula. Although the consortium as a whole has already, through the partners' expertise in their respective fields and their contacts and collaborations, the capacity to carry out the HYEEA activities, it is open to further (in particular complementary) partners aiming at broadening the representation of the member states, and making sure that the views of relevant organizations, institutions (and experts) throughout Europe are considered and incorporated.

3.4 Resources to be committed

The HYEEA consortium is composed of 7 leading institutions from both the DRM community and the ICT community. The project budget is well balanced between the project partners, between

the countries and between the functional areas DRM and ICT. The total cost of the project is 2989465 euro of EC contribution. Analyzing the projected budget, the following table presents the effort distribution (PMs) by activity type.

Type of activities	Person Months	Percentage of effort
Joint Research Activities	**87**	**22.5%**
Services Activities	**172.5**	**44.6%**
Networking Activities	**127**	**32.9%**

The following figure presents the total cost distribution by partner.

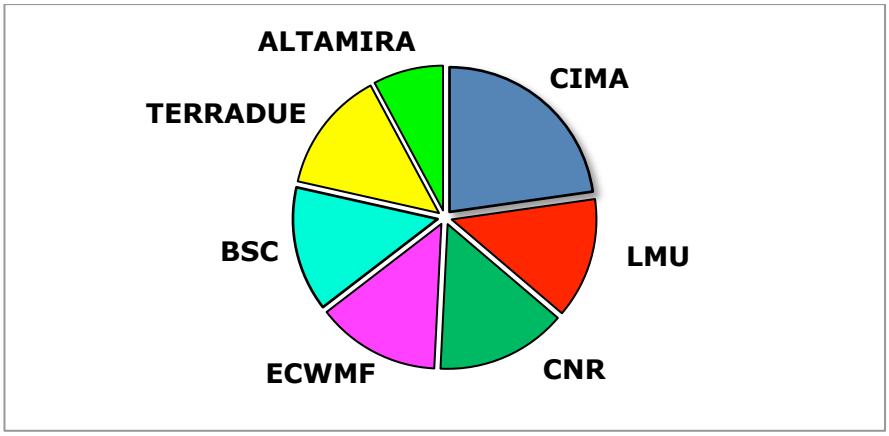


Figure 9: HYEEA total cost distribution by partner.

HYEEA project has been designed in the first place to leverage as much as possible work already accomplished and to utilize funding and manpower resources at the utmost both over the course of the project and beyond. Consequently, the efforts of research and development to be provided for advanced functionality, the integration with the European e-Infrastructures (global and thematic ones) and the provisioning of scalable and dependable services for DRM communities have been well balanced.

Access to high performance computing infrastructures will be provided for development and testing by LMU. For production runs, additional cycles will be requested through standard allocation procedures.

The resources allocated to the various work packages are well balanced while reflecting the focus of the call.

Table 3.4a: Summary of staff effort

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total Person/Months per Participant
1/CIMA	**13**	3	7	6	5	18	**33**	85
2/LMU	2	6	0	9	11	**24**	1	53
3/CNR	3	**20**	9	9	10	5	1	57
4/ECWMF	3	2	**6**	1	4.5	7	1	24.5
5/BSC	3	10	5	**30**	11	17	1	77
6/TERRA2	3	4	12	6	**21**	4	1	51
7/ALTA	11	4	2	3	5	13	1	39
Total Person/Months	38	49	41	64	67.5	88	39	386.5

4. Members of the consortium

4.1 Participants (applicants)

4.1.1 CIMA Research Foundation (CIMA, coordinator)

The Foundation, named Centro Internazionale In Monitoraggio Ambientale (International Centre On Environmental Monitoring), is a not for organization under the Italian Legal Regulations. The Founding Institutions were the Civil Protection Department of the Italian Prime Minister's Cabinet Office, the University of Genova, the Government of the Region of Liguria, and the Administration of the Province of Savona. A framework agreement between CIMA and University of Genoa is active for regulating joint activities in research programs. For this reason University of Genoa personnel is part of the team involved in the project work. CIMA is also International Affiliate Member of CUAHSI. HMR at CIMA deals with the study of uncertainty propagation in hydro-meteorological forecasting chains, the study of rainfall processes with the development of rainfall downscaling and hydrological models. CIMA has participated a several national and international HMR projects, and it coordinated a number of FP7 projects.

Main tasks in HYEEA project

- CIMA is the coordinator of the project (WP7) and it will lead WP1;
- CIMA will lead task WP1.1, task WP3.2, task WP4.2, task WP4.5, task WP6.1, task WP6.2, task WP6.6, task WP6.11, task WP7.1, task WP7.2

Short profile of key staff member

Antonio Parodi, male, PhD, Research Director at CIMA Research Foundation. Master Degree in Environmental Engineering, University of Genova, Italy (1998). Research Scholar at MIT - EAPS, (2002). Member of Radar Science Group at JPL-NASA (2009). His research interests are related to the development of simplified models of dry and moist convection and to the study of the main sources of uncertainty in the high-resolution numerical modelling of deep moist convective processes. He is author and co-author of 36 publications on international peer-reviewed journals. Project director of the FP7 projects DRIHMS (www.drihms.eu), DRIHM (www.drihm.eu), and DRIHM2US (www.drihm2us.eu). He will act as HYEEA Project Director.

Elisabetta Fiori, female, PhD, researcher at CIMA Research Foundation. Master Degree in Environmental Engineering, University of Genova, Italy (2005). Research activities in hydro-meteorology, in high resolution numerical modelling of intense convective events, in the study of its main sources of uncertainty and in the analysis of thermodynamics and kinematics properties of atmospheric processes due to deep moist convection.

Isabel Gomes, female, communication Expert (MA in Behaviour Change Communication) at CIMA Research Foundation, with 12 years work experience in the non-profit sector across Europe, Asia and Africa. Isabel's core experience and skills are Health Campaigns (AIDS/TB), Risk Communication (Natural Disasters/Disaster Risk Reduction) and Biodiversity Awareness.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

D'Agostino, D., Clematis, A., Galizia, A., Quarati, A., Danovaro, E., Roverelli, L., ... & Parodi, A. (2014, November). The DRIHM project: a flexible approach to integrate HPC, grid and cloud resources for hydro-meteorological research. In Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (pp. 536-546). IEEE Press.

Fiori, E., Comellas, A., Molini, L., Rebora, N., Siccardi, F., Gochis, D. J., ... & Parodi, A. (2014). Analysis and hindcast simulations of an extreme rainfall event in the Mediterranean area: The Genoa 2011 case. Atmospheric Research, 138, 13-29.

Hally, A., Caumont, O., Garrote, L., Richard, E., Weerts, A., Delogu, F., ... & Clematis, A. (2014). Hydro-meteorological multi-model ensemble simulations of the 4 November 2011 flash-flood event in Genoa, Italy, in the framework of the DRIHM project. Natural Hazards and Earth System Sciences Discussions, 2(11), 6653-6701.

Parodi, A., Boni, G., Ferraris, L., Siccardi, F., Pagliara, P., Trovatore, E., ... & Kranzlmueller, D. (2012). The "perfect storm": From across the Atlantic to the hills of Genoa. Eos, Transactions American Geophysical Union, 93(24), 225-226.
Quarati, A., Danovaro, E., Galizia, A., Clematis, A., D'Agostino, D., & Parodi, A. (2014). Scheduling strategies for enabling meteorological simulation on hybrid clouds. Journal of Computational and Applied Mathematics.
Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)
DRIHMS, short for Distributed Research Infrastructure for Hydro-Meteorology Study, is a project (www.drihms.eu, 2009-2011) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 246703.
DRIHM, short for Distributed Research Infrastructure for Hydro-Meteorology, is a project (www.drihm.eu, 2011-2015) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 283568.
DRIHM2US, short for Distributed Research Infrastructure for Hydro-Meteorology to US, is a project (www.drihm2us.eu, 2012-2015) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 313122.
EXPRESS-Hydro, short for EXtreme PREcipitation and Hydrological climate Scenario Simulations, Gauss Large Scale project, undertaking its activities in cooperation with the DRIHM project, to produce very high-resolution regional dynamical downscaling of historical climate scenarios produced by the ERA-Interim reanalysis and of climate change scenarios produced by a global climate model (the EC-Earth model), using the state-of-the-art non-hydrostatic Weather Research and Forecasting (WRF) regional climate model.
RASOR, short for Rapid Analysis and Spatialisation Of Risk, is a project (www.rasor-project.eu, 2013-2016) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 606888.
Significant infrastructure and/or any major items of technical equipment
CIMA is the coordinator of the DRIHM and DRIHM2US project, which developed an e-Infrastructure for Hydro-Meteorology research. Furthermore CIMA has access for research and operation purposes to the natural hazards modelling and observational data of the Italian Civil Protection Department, available through the DEWETRA platform.

4.1.2 Ludwig-Maximilians-Universität München (LMU)

The Munich Network Management Team (MNM-Team) is a research group led by Prof. Dr. Dieter Kranzlmüller at the Department of Computer Science of the Ludwig-Maximilians-Universität München (LMU). It is an inter-organisational team consisting of researchers at LMU, the Technische Universität München (TUM) and the Leibniz Supercomputing Centre (LRZ). Since its foundation more than 20 years ago, more than three hundred publications, over fifty Ph. D. theses, and several hundred Master and Diploma theses, supervised student projects and development project reports have been published.
The fundamental issues driving the research effort of the MNM-Team revolve around the manageability of networked and distributed systems, including adequate management concepts, tools, and IT processes, grid middleware development, grid infrastructure operation and resource management, as well as high performance and exascale computing. The team has played important roles in several EC-funded research and infrastructure projects, ranging from strategic Pan-European initiatives (including EGI_DS that built the architecture roadmap of the EGI.eu infrastructure as well as global standards and interoperability initiatives such as OGF-Europe, SIENA, gSLM and FedSM) to ambitious, problem-driven projects that combine major technical challenges to manageability issues (such as DRIHM project series developing advanced hydrometeorological solutions, MAPPER and COMPAT initiatives looking at different aspects of multi-scale modelling).

The work of the MNM-Team is based on practical experiences and knowledge gained from intensive co-operations with providers of large heterogeneous networks and software developers, as well as scientific research in the individual institutions of the MNM-Team. With the LRZ as the main IT provider for the Munich universities, the MNM-Team has access to a world-leading IT-infrastructure including the energy- efficient petascale system SuperMUC.

The MNM-Team comprises around 30 researchers (about half of them pursue their Ph.D. studies), as well as numerous students and administrative staff. By virtue of its unique approach that covers the whole IT lifecycle (from the theoretical computer science research to managing IT-based services) MNM-Team can effectively support and catalyse the maturing process of individual software components from proof-of-concepts to production solutions, as well as linking components from different sources, disciplines and paradigms into cohesive whole with a consistent, shared conceptual model.

For the successful completion of this project the whole range of the MNM-Team skills and expertise are relevant and needed, with LMU having the mandate to coordinate the research activities and to represent the MNM-Team in the project.

Main tasks in HYEEA project

- LMU leads WP6
- LMU will lead task WP5.2, task WP6.4, task WP6.5, task WP6.7

Short profile of key staff member

Dieter Kranzlmüller, male, is full Professor of computer science at LMU, and member of the board of directors of the Leibniz Supercomputing Centre (LRZ), which is a hosting partner in PRACE providing access to the world-class leadership machine SuperMUC Phase 1+2. He has worked in parallel computing and computer graphics since 1993, with a special focus on parallel programming and debugging, cluster and especially grid computing. He has participated in several national and international research projects, has been acting as reviewer and international expert for several countries and research programmes, and has co-authored more than 150 scientific papers in journals, and conference proceedings. At present, he serves as a member of the EGI.eu Executive Board, chairman of the EGI-InSPIRE Project Management Board, and German representative on the EGI Council. Before moving to Munich, he has been deputy head of GUP, the Institute of Graphics and Parallel Processing at the Johannes Kepler University Linz, Project Director and later Strategic Director of EGI_DS, appointed national representative of Austria in the EC e-Infrastructures Reflection Group (e-IRG), and member of the Austrian Grid Executive Board.

Dr. Nils gentschen Felde, male, holds a PhD in Computer Science from Ludwig-Maximilians-Universität München. He is senior researcher of the MNM-Team at the Department of Computer Science at LMU. His research interests include Grid and Cloud computing, service management, service dependability, IT security and critical IT infrastructures. Currently, he is involved as senior researcher in several nationally and internationally funded projects. Since obtaining his PhD, he is also contributing in local management roles for collaborations with industrial partners, and as local manager of the MNM-Team contribution in EU projects such as OGF-Europe, DRIHM and DRIHM2US.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

D'Agostino, D., Clematis, A., Galizia, A., Quarati, A., Danovaro, E., Roverelli, L., ... & Parodi, A. (2014). The DRIHM project: a flexible approach to integrate HPC, grid and cloud resources for hydro-meteorological research. In Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (pp. 536-546). IEEE Press.

Schiffers, M., Kranzlmüller, D., Clematis, A., D'Agostino, D., Galizia, A., Quarati, A., ... & Tafferner, A. (2011). Towards a grid infrastructure for hydro-meteorological research. Computer Science, 12, 45-62.

Schiffers, M., Kranzlmüller, D.: A Grid-Infrastructure for Environmental Computing, accepted for International Symposium on Grids and Clouds (ISGC) 2015, March 2015, Taipei, Taiwan
Velázquez, J.A., Schmid, J., Ricard, S., Muerth, M., Gauvin St-Denis, B., Minville, M., Chaumont, D., Caya, D., Ludwig, R. and R. Turcotte (2013): An ensemble approach to assess hydrological models' uncertainties in the analysis of climate change impact on water resources. In: Hydrol. Earth Syst. Sci., 17, 565–578.
Beniston, M., Stoffel, M., Harding, R., Kernan, M., Ludwig, R., Moors, E., Samuels, P. and K. Tockner (2012): Obstacles to data access for research related to climate and water: implications for science and EU policy. Env. Sc. and Policy, 17, 41-48

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)

DRIHM (Distributed Research Infrastructure for Hydro-Meteorology, www.drihm.eu) – EU funded project; duration: 2011-2015, coordinator: Antonio Parodi, CIMA Research Foundation, Savona/Italy, main topic: provision of an open, fully integrated workflow platform for predicting, managing and mitigating risks related to extreme weather phenomena based on Grid computing infrastructures. In the DRIHM context support for EXPRESS-Hydro (EXtreme PREcipitation and Hydrological climate Scenario Simulations, www.drihm.eu/index.php/documents/news/166-express-hydro), a Gauss Large Scale project, to produce very high-resolution regional dynamical downscaling of historical climate scenarios.
DRIHM2US (Distributed Research Infrastructure for Hydro-Meteorology to United States of America, www.drihm2us.eu) – EU funded project; duration: 2012-2015, coordinator: Antonio Parodi, CIMA Research Foundation, Savona/Italy, main topic: understanding the utilization of e-Infrastructures for advancing scientific collaboration on both sides of the Atlantic towards improving the predictive ability of severe storms and utilization of these predictions for hazard prediction and control under climate change effects
Significant infrastructure and/or any major items of technical equipment
LMU has direct access to one of the fastest computing resources and one of the largest data storage facilities worldwide. As part of its Grid and HPC activities, LMU also has access to the most capable European e-infrastructures like EGI and PRACE. Through their cooperation with the University of Berkeley, University of Virginia, and Rutgers University, access to the US XSEDE environment and their science gateways is provided, a unique opportunity for HYEEA.
LMU provides a world-class 3D Virtual Reality and Visualisation CAVE as an ideal training and simulation facility. In the CAVE, immersive projection technology supports interacting with science datasets in an intuitive way and display them stereoscopically.

4.1.3 Consiglio Nazionale delle Ricercher (CNR)-IMATI

Consiglio Nazionale delle Ricerche (CNR) is the major public research body in Italy, a multidisciplinary institution that actively participated to the different FP programmes of EU.
In HYEEA, CNR is represented by the **Institute of Applied Mathematics and Information Technology (IMATI)**.
IMATI is a leading institute in the fields of applied mathematics and Computer science. IMATI-CNR has its headquarter in Pavia and branches in Genova and Milano. The institute has a long tradition of coordination of national and international research projects (including coordination of a NoE in the 6th FP, and of two Ideas projects in the 7th FP). IMATI-CNR is fully involved in the Grid activities carried out by CNR at the national and international level, including participation to IGI (Italian Grid Infrastructure) and EGI (European Grid Initiative).
Main tasks in HYEEA project

- IMATI leads WP2
- CNR will lead task WP2.1, task WP2.3, task WP3.3, task WP4.3, task WP5.1

Short profile of key staff member
Andrea Clematis, male, is Research Director of the research group on high performance and Grid computing; deputy Director of the Grid lab of SIIT, a technological District including University of

Genova, CNR, a number of companies, and around 70 SME; Chair of Euromicro Tech. Com. on Parallel and Distributed Processing; editor for Parallel and Distributed Systems of Journal of Systems Architecture, Elsevier. Research includes Grid and parallel computing, distributed visualization and image processing. He is author and co-author of more than 130 technical papers, and leader for IMATI in more than 20 research projects (NATO, British Council, EC, CNR, others).
Daniele D'Agostino, male, PhD, researcher at CNR-IMATI, works in the area of high performance computing on complex environments. In particular his research activities concern the design of high performance software and the resource management in Grid and Cloud environments, with a focus on Hydro-meteorological analysis and Bioinformatics applications. He co-authored more than 50 scientific papers and in 2014 was one of the co-chair of the Euromicro International Conference on Parallel, Distributed and Network-Based Processing (PDP).
Antonella Galizia, female, PhD, obtained the Laurea Degree cum laude in Mathematics at the University of Naples in December 2001, and a Ph.D. in Computer Science at the University of Genova in May 2008. In June 2003 she started her research activity at the IMATI-CNR Genova. Her research interests are in the fields of parallel and distributed computing for the effective and efficient exploitation of advanced computing systems to improve the quality of software for advanced applications. In particular, she investigates Hydro-meteorological and Bioinformatics applications.
Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)
D'Agostino, D., Clematis, A., Galizia, A., Quarati, A., Danovaro, E., Roverelli, L., ... & Parodi, A. (2014, November). The DRIHM project: a flexible approach to integrate HPC, grid and cloud resources for hydro-meteorological research. In*Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis* (pp. 536-546). IEEE Press.
Danovaro, E., Roverelli, L., Zereik, G., Galizia, A., DAgostino, D., Paschina, G., ... & Richard, E. (2014, October). Setting Up an Hydro-Meteo Experiment in Minutes: The DRIHM e-Infrastructure for HM Research. In *e-Science (e-Science), 2014 IEEE 10th International Conference on* (Vol. 1, pp. 47-54). IEEE.
Quarati, A., Danovaro, E., Galizia, A., Clematis, A., D'Agostino, D., & Parodi, A. (2014). Scheduling strategies for enabling meteorological simulation on hybrid clouds. Journal of Computational and Applied Mathematics.

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)
DRIHMS, short for Distributed Research Infrastructure for Hydro-Meteorology Study, is a project (www.drihms.eu, 2009-2011) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 246703.
DRIHM, short for Distributed Research Infrastructure for Hydro-Meteorology, is a project (www.drihm.eu, 2011-2015) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 283568.
DRIHM2US, short for Distributed Research Infrastructure for Hydro-Meteorology to US, is a project (www.drihm2us.eu, 2012-2015) co-funded under the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 313122.
Significant infrastructure and/or any major items of technical equipment
CNR-IMATI was one of the main developers of the science gateway (https://portal.drihm.eu) representing the core of the e-Infrastructure for Hydro-Meteorology research used in DRIHM and DRIHM2US.

4.1.4 European Centre for Medium-Range Weather Forecasts (ECMWF)

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an international organisation supported by 34 States: 20 Members (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom) and 14 Co-operating

Members (Bulgaria, Croatia, Czech Republic, Estonia, the former Yugoslav Republic of Macedonia, Hungary, Israel, Latvia, Lithuania, Montenegro, Morocco, Romania, Serbia and Slovakia). ECMWF's principal objectives are the preparation, on a regular basis, of medium-range and long-range weather forecasts for distribution to the meteorological services of the Member States, the development of scientific and technical research directed to the improvement of these forecasts, and the collection and storage of appropriate meteorological data. ECMWF's computer facility includes supercomputers, archiving systems and networks.

ECMWF is the Archive Centre for TIGGE and TIGGE-LAM and it is in the process of building the system for acquiring, archiving and serving S2S data.

ECMWF is also the operational computational centre for the European and Global Flood Awareness System (EFAS and GLOFAS, part of Copernicus Emergency services) and executes forecasts and hosts the EFAS-Information System platform. EFAS provides medium range flood warnings in Europe in support of the European Community. GLOFAS (www.globalfloods.eu) provides global flood warnings, which are used by various stakeholders such as the Red Cross the World Food Program, the European Emergency Response Coordination Centre (ERCC) and many other national agencies. ECMWF has active research and pre-operational products in other preoperational activities such as Wild fire forecast.

Main tasks in HYEEA project

- ECMWF leads WP3
- ECMWF will lead task WP2.4, task WP3.1, task WP5.5, task WP6.8, task WP6.10

Short profile of key staff member

Florian Pappenberger, male, is a principal scientist at ECMWF responsible for a team working in the area of applications of Numerical Weather Predictions including fire, droughts, malaria, energy and floods. He also leads the computational centre of the European Flood Awareness System, responsible for all operational aspects of these medium range flood forecasts. He is a Guest Professor at Hohai University (Nanjing, China) and University of Bristol (Bristol, United Kingdom). His expertise in flood forecasting, hydrological modelling and uncertainty analysis is documented in over 80 publications in international peer reviewed journals and book chapters. His awards include the Arne Richter Award for Outstanding Young Scientists from the European Geosciences Union for his work on Hydrological Ensemble Predictions and the Outstanding Editor Award of the Hydrology and Earth System Sciences Journal. He is part of the EFAS team, which received the IES Excellence Award for 'Support to EU Policy' (a European Commission award). He has consultant for the Environment Agency of England and Wales on probabilistic flood forecasting and also works with Industry partners. Until recently, he was also co-chair of the international Hydrological Ensemble Prediction Experiment (HEPEX, www.hepex.org). Florian has led several large European projects on water scarcity and drought predictions (DEWFORA, GLOWASIS), developing a risk culture for Europe (KULTURISK) and European and global flood forecasting (GloFas, EFAS). He also works on global river modelling, ensemble verification and the impact of the uncertainty in land surface processes on seasonal predictions.

Calum Baugh, male, is a scientist in the Forecast Department at ECMWF whose role is in the development of flash flood warnings in both the EFAS and GloFAS systems, he has been in this role since January 2015. Prior to this he completed his PhD in the Geography department at the University of Bristol in June 2014 on the hydraulic modelling of the Amazon river floodplain. Then he worked at the World Food Programme in Rome developing automated GIS routines to analyse and communicate the global risk posed to food insecure communities by tropical cyclones. He has peer-reviewed publications in international journals and has been a reviewer for Journal of Hydrology and Environmental Remote Sensing.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

1. Products: TIGGE, the THORPEX Interactive Grand Global Ensemble, is a key component of THORPEX: a World Weather Research Programme to accelerate the improvements in the accuracy of 1-day to 2-week high-impact weather forecasts for the benefit of humanity. The TIGGE archive consists of ensemble forecast data from ten global NWP centres. TIGGE-LAM is an extension of the TIGGE archive to include Local Area models.
2. Services: Magics++ and Metview: Magics++ is the latest generation of the ECMWF's Meteorological plotting software Magics. This object-oriented software supports the contouring of fields, plotting of wind fields, observations, satellite images, symbols, text, axis and graphs. Magics can visualise various formats, for instance GRIB 1 and 2 code data, gaussian grid, regularly spaced grid and fitted data. GRIB data is handled via ECMWF's GRIB API software. Input data can also be in BUFR and NetCDF format or retrieved from an ODB database
3. Packages: ecFlow is a work flow package that enables users to run a large number of programs (with dependencies on each other and on time) in a controlled environment. It provides reasonable tolerance for hardware and software failures, combined with good restart capabilities.

Zsoter, E., Pappenberger, F. and Richardson, D., 2014, Sensitivity of model climate to sampling configurations and the impact on the Extreme Forecast Index. Met. Apps. doi: 10.1002/met.1447
Dale, M., Wicks, J., Mylne, J., Pappenberger, F., Laeger, S., 2014, Probabilistic flood forecasting and decision-making: an innovative risk-based approach, Natural Hazard, 70(1), 159-172, 10.1007/s11069-012-0483-z
Wetterhall, F., Pappenberger, F., Alfieri, L., Cloke, H. L., Thielen-del Pozo, J., Balabanova, S., Daňhelka, J., Vogelbacher, A., Salamon, P., Carrasco, et al.: HESS Opinions "Forecaster priorities for improving probabilistic flood forecasts", Hydrol. Earth Syst. Sci., 17, 4389-4399, doi:10.5194/hess-17-4389-2013, 2013
Pappenberger, F., Stephens, E., Thielen, J., Salamon, P., Demeritt, D., van Andel, S. J., Wetterhall, F. and Alfieri, L., 2013, Visualizing probabilistic flood forecast information: expert preferences and perceptions of best practice in uncertainty communication. Hydrol. Process., 27: 132–146. doi: 10.1002/hyp.9253

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)

1. GEOWOW – The GEOSS Interoperability for Weather, Ocean and Water is a project co-funded under the European Community's Seventh Framework Programme FP7/2007-2013. GEOWOW's challenge is to improve Earth Observation data discovery, accessibility and exploitability, and to evolve the Global Earth Observation System of Systems (GEOSS) for the benefit of all Societal Benefit Areas (SBAs) with particular focus on Weather, Ocean Ecosystems and Water;
2. EFAS & GloFAS - The European Flood Awareness System (EFAS), developed to produce European overviews on ongoing and forecasted floods, contributes to better protection of the European Citizen, the environment, property and cultural heritage in support to the EU Mechanism for Civil Protection. Since 2012 EFAS is an operational service under the umbrella of the Copernicus emergency management service and run by Member States organisations. The Global Flood Awareness System (GloFAS), jointly developed by the European Commission and the European Centre for Medium-Range Weather Forecasts (ECMWF), couples state-of-the art weather forecasts with a hydrological model and with its continental scale set-up it provides downstream countries with information on upstream river conditions as well as continental and global overviews. GloFAS produces daily flood forecasts in a pre-operational manner since June 2011;
3. GLOWASIS - Global Water Scarcity Information Service was a collaborative European FP7 project aimed at pre-validation of a GMES Global Water Scarcity Information Service. GLOWASIS provided open data on water scarcity and made use of data from GMES Core Services Land and Ocean;
4. Earth2Observe - Global Earth Observation for Integrated Water Resource Assessment is a collaborative project funded under the DG Research FP7 programme (2014-2017). The overall objective is to contribute to the assessment of global water resources through the

use of new Earth Observation datasets and techniques. The project will integrate available earth observations, in-situ datasets and models, to construct a consistent global water resources reanalysis dataset of sufficient length (at least 30 years). The resulting datasets will be made available through an open Water Cycle Integrator data portal: the European contribution to the GEOSS/WCI approach. The datasets will be downscaled for application in case studies at regional and local levels, and optimized based on identified European and local needs supporting water management and decision-making;

5. CHARMe - Sharing knowledge about climate data is a FP7 project aimed to allow users to view or create annotations that describe how climate data has been used and what has been learned. The CHARMe system collects and shares annotations associated with climate datasets. This information is called commentary metadata. Users will be able to add or view commentary metadata, complementing existing information from the data providers. The CHARMe system provides links between datasets and citations and other commentary information using open standards such as Open Annotation. This approach is highly flexible and can adapt to changing user needs as the system grows.

Significant infrastructure and/or any major items of technical equipment

ECMWF's Meteorological Archive and Retrieval System (MARS) is the software used to manage the Centre's archive of meteorological data and to provide access to the data. It has two main components, the MARS Server and the MARS Client. Some of the features of the MARS system are: provides facilities to archive and retrieve meteorological data; MARS holds Terabytes of data, mainly using GRIB format for meteorological fields and BUFR format for meteorological observations; for large archives, MARS needs a tape management system for off-line storage. Current tape management systems supported are Tivoli Storage Manager (TSM), High Performance Storage System (HPSS), Veritas, VolCentre; provides monitoring facilities for operators and administrators enables easy archive and retrieval access via a pseudo-meteorological language; batch and interactive modes are supported, including web access; supports large amounts of data, both in volume and number of items stored; supports a large number of users with differing requirements, e.g. retrieving large data sets occasionally or small data sets at frequent intervals; (Details: old.ecmwf.int/products/data/software/mars.html). The grib_api is the application program interface developed at ECMWF to provide an easy and reliable way for encoding and decoding WMO FM-92 GRIB edition 1 and edition 2 messages. With the grib_api library, that is written entirely in C, some command line tools are provided to give a quick way to manipulate grib data. Moreover, a Fortran 90 interface is available giving access to the main features of the C library.

4.1.5 Barcelona Supercomputing Center (BSC)

BSC was established in 2005 and is the Spanish national supercomputing facility and a hosting member of the PRACE distributed supercomputing infrastructure. BSC houses MareNostrum, one of the most powerful supercomputers in Europe. The mission of BSC is to research, develop and manage information technologies in order to facilitate scientific progress. BSC combines HPC service provision and R&D into both computer and computational science (life, earth and engineering sciences) under one roof and currently has over 400 staff from 41 countries. BSC has collaborated with industry since its creation, and participates in various bilateral joint research centres with companies such as IBM, Microsoft, Intel, NVIDIA and Spanish oil company Repsol. The centre has been extremely active in the EC Framework Programs and has participated in seventy-nine projects funded by it. BSC is a founding member of HiPEAC, the ETP4HPC and other international fora.

The Earth Sciences department of the Barcelona Supercomputing Center (ES-BSC) conducts multi-facet research in Earth system modelling. Established in 2006, the initial core activity was focused on atmospheric composition modelling. The designation of Prof. Francisco J. Doblas-Reyes as Director of the ES-BSC in 2014 initiated the merging of the ES-BSC with the Climate Forecast Unit of the Institut Català de Ciències del Clima (IC3-CFU), which he was leading and who had become

in a short time a main European actor in the development of climate predictions and climate services. The newly merged department is structured around four groups with more than 50 employees, including technical and support staff: 1) climate prediction group, 2) atmospheric composition group, 3) earth system services group, and 4) computational earth sciences group.

The ES-BSC is heavily involved in the progress and application of seasonal forecasting paying special attention to both the identification of the main sources of predictability (including sea ice and soil characteristics) and the development of climate services. The Department has experience in the application of seasonal forecasting to water management and its personnel is currently developing strategies to identify the key characteristics that a climate service should have, with special attention to the renewable energy and agriculture.

Main tasks in HYEEA project

- BSC leads WP4
- BSC will lead task WP2.2, task WP4.1, task WP4.3, task WP4.4, task WP6.3, task WP6.9

Short profile of key staff member

Msc. Kim Serradell Maronda, male, is Bachelor (2005) in Computer Sciences for the Facultat d'Informàtica de Barcelona (FIB-UPC) and for the Grande école publique d'ingénieurs en informatique, mathématiques appliquées et télécommunications de Grenoble (ENSIMAG). Since 2014 is also Master on High Performance Computing from the Facultat d'Informàtica de Barcelona (FIB-UPC). Currently, he is the co-manager of the Computational Earth Science (CES) group at the Earth Sciences department in the Barcelona Supercomputing Center (BSC). The CES group is a multidisciplinary team of 15 members with different IT profiles that interacts closely with all the other groups of the Earth Sciences Dept. In the last years, he has been in charge for the system administration of all the computational esources of the department and he was also responsible of supervising the operational runs of the NMMB/BSC-Dust model and CALIOPE Air Quality System in the HPC infrastructures of the BSC. He has been involved in European projects like IS-ENES (1 & 2), ESiWACE, SDS-WAS, BDFC or CONSOLIDER.

Dr. Isadora Christel Jiménez, female, has a Master's degree in Science communication (IDEC-UPF) and a PhD in offshore wind energy Impact assessment from the University of Barcelona. She has eight years of research experience in direct contact with stakeholders and five years working on science communication. As the science communication specialist of the Services group at BSC-ES she facilitates knowledge and technology transfer to end users. She is currently involved in EU funded projects in dissemination actions, user-engagement activities and the interaction with stakeholders to promote the integration of seasonal-to-decadal climate predictions in different economic sectors. She is Work Package leader within EUPORIAS and PRIMAVERA and she is also involved in user engagement and dissemination Work Packages in IMPREX, SPECS, ClimatEurope and CLIM4ENERGY.

Dr. Albert Soret, male, holds a PhD in Environmental Engineering from the Polytechnic University of Catalonia (Barcelona). He is head of the Services group at BSC-ES. He is a postdoc researcher with 10 years of experience in earth sciences. His research focuses on assessing the impact of climate on socio-economic sectors through the development of user-oriented services that ensure the transfer of the technology developed and the adaptation to a rapidly changing environment. He is Work Package leader within the CLIM4ENERGY project. Between others, he is participating in EC-FP7 and H2020 projects: NEWA, EUPORIAS, SPECS, IMPREX and PRIMAVERA.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

- Autosubmit: a versatile tool to manage Weather and Climate Experiments in diverse Supercomputing Environments. https://pypi.python.org/pypi/autosubmit/
- UKKO: seasonal wind prediction prototipe for the energy sector. http://project-ukko.net/
- Buontempo, C., C.D. Hewitt, F.J. Doblas-Reyes and S. Dessai (2014). Climate service development, delivery and use in Europe at monthly to inter-annual timescales. Climate Risk Management, 6, 1-5, doi:10.1016/j.crm.2014.10.002.
- Doblas-Reyes, F.J., J. García‐Serrano, F. Lienert, A. Pintó Biescas and L.R.L. Rodrigues (2013). Seasonal climate predictability and forecasting: status and prospects. WIREs Climate Change, 4, 245-268, doi:10.1002/WCC.217.
- Soret, A., Gonzalez, N., Torralba, V., Cortesi, N., Doublas-Reyes, F. J. (2016). Climate predictions for vineyard management. ClimWine2016, Bordeaux, France, 10-13 April.

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)

- **SPECS**: Seasonal-to-decadal climate Prediction for the improvement of European Climate Services. SPECS is a FP7 European project undertakes research to produce reliable climate predictions by identifying the main problems in climate prediction and investigate a battery of solutions from a seamless perspective.
- **EUPORIAS**: European Provision Of Regional Impact Assessment on a Seasonal-to-decadal timescale. EUPORIAS is a FP7 European project that has develops and deliver reliable predictions of the impacts of future climatic conditions on different sectors such as agriculture and water. Climate predictions come with a new set of challenges for end users: information is often un-tailored and hard to understand or apply in a decision-making context. A new generation of European projects, including SPECS and EUPORIAS aim to address these challenges and support the development of a new realm of climate services and tools using climate predictions.
- **IMPREX**: IMproving PRediction and management of hydrological EXtremes. IMPREX is a FP7 European project undertakes research for a better anticipation on future high impact hydrological extremes disrupting safete of citizens, agricultural production, transportation, energy production and urban water supply.

Significant infrastructure and/or any major items of technical equipment

MARE NOSTRUM: MareNostrum has a peak performance of 1,1 Petaflops, with 48,896 Intel Sandy Bridge processors in 3,056 nodes, including 84 Xeon Phi 5110P in 42 nodes, with more than 115 TB of main memory and 2 PB of GPFS disk storage. At June 2013, MareNostrum was positioned at the 29th place in the TOP500 list of fastest supercomputers in the world.

AUTOSUBMIT: Autosubmit is a versatile tool to manage weather, air quality and climate experiments in diverse supercomputing environments. It is a Python tool, to create, run and monitor experiments by using computing resources available at Computing Clusters, HPC and Supercomputers. It offers support for experiments running in more than one supercomputing platform and for different workflow configurations. Autosubmit manages the submission of jobs to queue scheduler, until there is no job left to be run. Additionally, it also provide features to suspend, resume, restart and extend similar experiment at later stage.

4.1.6 TERRADUE (TERRA2) SRL

Terradue Srl addresses the Earth Sciences research & education sector, with core competencies aimed at engineering distributed systems and Cloud services, providing consultancy for international organizations, and developing partners programs in support of Terradue's Open

Source Platforms and Standardization strategy. Terradue is a leading Cloud Services provider with current developments focusing on empowering researchers within seamless eScience infrastructures, for curating and delivering scientific information, and to create Cloud marketplaces for environmental data analytics and promoting a vision where scientific publications are fully reproducible, verifiable experiments and part of an interoperable ecosystem.
The company founders worked for nearly four years in the development of the Grid infrastructure in European Space Agency Centre for Earth Observation (ESRIN), the G-POD (Grid Processing on Demand for Earth Observation). Since 2006 Terradue maintains and supports the integration of operational applications and services according to ESA Software Engineering standards. Terradue gained strong experience in application integration with the integration of the ESA Earth Observation routine production processors and Principal Investigators scientific applications on the infrastructure in the frame of a dedicated announcement of opportunities.
With the FP7 projects GENESI-DR and GENESI-DEC starting in 2008, a new vision took shape to facilitate the discovery, access and use of Earth-related data from space, airborne and in-situ sensors archived in large distributed repositories. This lead to the promotion of OpenSearch as the baseline for discovery services interoperability and federation of EO data catalogues. The development of spatial, temporal and EO extensions standards by Terradue was adopted in 2014 by the OGC and applied by across different space agencies (e.g. NASA, ESA, JAXA, INPE).
The Cloud platform development started in 2009 and was subsequently supported by research and development activities from several ESA and EC FP7 projects, like GEOWOW and SenSyF, and is now in a stable and operational environments. Since 2011 Terradue already supported the on-boarding of more than 30 complex EO applications with more than 80 active developers from different institutions and commercial companies.
In 2014, Terradue was deeply involved in the initial ESA activities to initiative the development of an ecosystem of Thematic Exploitation Platforms (TEP) focuses on the capitalization on Ground Segment capabilities and ICT technologies to maximize the exploitation of EO data from past and future missions. The Exploitation Platforms are targeted to cover different capacities and define, implement and validate a platform for effective data exploitation of EO data sources in a given thematic area. ESA started in 2015 a total of 6 projects that address the thematic areas: Coastal Environment, Forestry, Hydrology, Polar, Urban and Geohazards. Terradue is currently leading the GeoHazard TEP consortium and also participating on the implementation of the Urban TEP, led by the DLR German Aerospace Center, and on the Hydrology TEP led by the isardSAT Group. In all three TEP, Terradue leads the tasks of implementation and integration of thematic services on Earth Observation Cloud Platform.

Main tasks in HYEEA project
TERRA2 brings to the consortium its expertise in the provision of EO data and distributed computing platforms, enabling scientific applications to exploit distributed processing capabilities without re-engineering them. Terradue's team has the experience and established procedures to manage successfully the integration of the pilot applications in this project.
TERRA2 will lead WP5 and task WP5.3, and task WP5.4.

Short profile of key staff member

Dr. Pedro Gonçalves, male, Terradue founder and Chief Technical Officer. Pedro is an Environmental Engineer and did a post-doc in ESA-ESRIN where he led the development and transfer to operations of the G-POD. Pedro is the editor and collaborator of several Open Geospatial Consortium specifications dealing with discovery and access of Earth science information focusing on integration with the Open Linked Data architecture. Pedro will manage Terradue activities in the project focusing on leveraging the processing power and agility of cloud computing for the development of new exploitation platforms for environmental and climate change data.

Cesare Rossi, male, focuses on developing and maintaining a high performance and distributed computing infrastructure to support EO applications, by leveraging well known programming models for processing and generating large data sets with distributed algorithms (MapReduce). Cesare is involved in performance analysis of EO algorithms in distributed and hybrid Cloud environments, collecting execution metrics and presenting results in a comprehensive manner. Cesare has a strong academic background, with a particular interest in distributed systems and high performance computing (Grid Computing and Cloud Computing), developed during five years at the University of Rome "Tor Vergata" and a year of trainee at the ESRIN - ESA's centre for Earth observation. Cesare will help partners to fully explore the capabilities of parallel computing for EO data processing in the development and integration cycle of applications (processors and algorithms). It will guide them in the concept of data processing workflows (a.k.a. data pipelines) to facilitate the data flow, repeatable and systematic tasks, effective large-scale data management, multidisciplinary analysis, and adequate data source identification.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

- On Processing Extreme Data, Dana Petcu, Gabriel Iuhasz, Daniel Pop, Domenico Talia, Jesus Carretero, Radu Prodan, Thomas Fahringer, Ivan Grasso, Ramon Doallo, Maria J. Martin, Basilio B. Fraguela, Roman Trobec, Matjaz Depolli, Francisco Almeida Rodriguez, Francisco de Sande, Georges Da Costa, Jean-Marc Pierson, Stergios Anastasiadis, Aristides Bartzokas, Christos Lolis, Pedro Goncalves, Fabrice Brito, Nick Brown, Scalable Computing: Practice and Experience Volume 16, Number 4, pp. 467–489. DOI 10.12694/scpe.v16i4.1134
- Global monitoring of plankton blooms using MERIS MCI, J Gower, S King, P Goncalves Inter. Journal of Remote Sensing 29 (21), 6209-6216, 2008
- Building a mosaic of clouds, B Di Martino, D Petcu, R Cossu, P Goncalves, T Máhr, Euro-Par 2010 Parallel Processing Workshops, 571-578, 2011
- Variational optimization for global climate analysis on ESA's high performance computing grid, A Löscher, C Retscher, L Fusco, P Goncalves, F Brito, Remote Sensing of Environment 112 (4), 1450-1463, 2008
- GENESI-DR Portal: a scientific gateway to distributed repositories, P Goncalves, F Brito, F D'Andria, R Cossu, L Fusco, EGU General Assembly Conference Abstracts 12, 12234, 2010

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)

ESA Grid Processing on-Demand

Grid Processing on-Demand (G-POD), an ESA-initiated project industrialized by Terradue since mid-2006, provides a "user-segment" putting EO data and processors closer together. This common shared infrastructure, accessible to science users and operations provides cost- effective support for EO operations, science and application development. The G-POD is a hybrid Grid/Cloud based high-performance and high throughput computing infrastructure promoting the access to Earth Observation data, offering online access to products with attached computing infrastructure and tools to generation of scientific added value products. Today, this solution manages over 350 computing nodes in ESA-ESRIN and ESA UK-PAC hosting a large number of EO processors and scientific applications running against several tens of Terabytes of on-line EO data. Terradue is responsible for the maintenance and evolution of the G-POD and for the integration of the ESA EO routine production processors and Principal Investigators scientific applications within the framework of G-POD Cat-1.

GENESI-DEC

The EC FP7 GENESI-DEC was a FP7 project that provided data discovery, access, processing and visualization mechanisms to several Digital Earth Communities with a strong accent on distributed infrastructures security, semantics, ontology and advanced workflow management.

Terradue had a major role in the infrastructure architecture and services (data discovery, catalogue, access and processing) and performed research activities targeting the fast data access and computing resources virtualization.

GEOWOW

The EC FP7 GEOWOW project addressed the challenge to evolve the GEO Global Earth Observation System of Systems (GEOSS) in terms of interoperability, standardization and functionality, to the final purpose of providing users with improved discovery, access and usability of Earth Observation data and services. Terradue made contributions to the GEOSS architecture with special emphasis on the initial development for data discovery, access and processing using Developer Cloud Sandbox solution.

SENSYF

A FP7 project kicked-off in January 2013, and will last until the end of 2015. The project provides a specialised Cloud Platform service where partners are empowered to develop, test and deploy at scale new processing chains and methods for Sentinel and Copernicus/GMES contributing mission data on a continuous basis. It delivers higher-level products and services complementing the information provided by the operational services. Terradue's responsibilities are the service integration, deployment, operations and support of the SenSyF infrastructure.

SuperSites Exploitation Platform

The SuperSites Exploitation Platform (SSEP) project brought together existing software components and EO data allowing geohazard scientists to apply their algorithms and tools to analyse the data in Cloud Computing environment, with an technical emphasis on avoiding Cloud vendor lock-in. It represented ESA contribution to the GEO Supersites initiative. The developments contributed by Terradue comprised an instance of an exploitation platform for radar imagery in the context of geohazards, for sharing data and exploitation of interferometry processing.

Significant infrastructure and/or any major items of technical equipment

Terradue Cloud Platform is designed for two ICT provisioning scenarios in mind. The first scenario relies on a stable and predictable demand on the infrastructure (for persistent storage of large, stable datasets and for systematic processing), where it is possible to predict the need and consequently size the ICT a-priori. ICT resources rental or subscription to dedicated hosting solutions is used for this scenario.

The second scenario is for applications that rely on growth hypothesis to scale up their processing and/or storage needs associated with variable, time-limited or unpredictable demands on the infrastructure. The Terradue Cloud Platform is ready for provisioning resources through cloud bursting for dynamically covering such needs. The core services of the Terradue Cloud Platform are currently located at Hetzner Online AG facilities in Germany. Hetzner is a strategic partner of Terradue and it is responsible of the bare metal maintenance operations and it guarantees the normal working of the IT infrastructure itself. The ICT facility is a Private Cloud platform, delivering PaaS and SaaS resources to the Earth Observation scientific community. It is built as a cluster of management servers and clusters of high performance workers nodes. It includes a Simple Storage Service (S3) elastic storage with 20TB for reference datasets. Different VM configurations exist in order to serve different computing requirements.

The management part of the infrastructure provides services to the infrastructure and users like the VPN service, the first level Support system, and the IaaS cloud controller.

The Terradue Development Infrastructure is located in Rome on the company's own premises, where the maintenance operations are directly performed by the Terradue's Operational Team. The TDI is a Private Cloud platform to provide PaaS and IaaS services to the Terradue's Development Team. It is built as a cluster of management servers, a cluster of workers nodes and a cluster of storage nodes. Similarly VM configurations exist in order to serve different computing

requirements for the development and testing activities. The management part of the infrastructure provides services like the VPN and the IaaS cloud-dev controller.

4.1.7 ALTAMIRA INFORMATION

ALTAMIRA INFORMATION is an experienced Earth Observation company that offers client-oriented solutions in ground motion and mapping products to major industry sectors: Oil and Gas, Infrastructure, Mining, Insurance, Environment, Natural Hazards, and Research and Space. Specific to hydrology and water management, ALTAMIRA INFORMATION offers cartographic products such as the detection of water bodies and measurements of water heights, hydro-flattening, flooding and wetland monitoring.
ALTAMIRA INFORMATION was founded in Barcelona in 1999 and opened offices in Toulouse (France) and Calgary (Canada). ALTAMIRA team brings together 40 staff with a wide technical and scientific background on (i) Advanced SAR/InSAR developments and applications; (ii) Distributed Information Systems and Visualization applications; (iii) Operational processing of large volumes of EO data (iv) Project management at a European level and a good working knowledge of the structures and procedures of international organisations.
ALTAMIRA INFORMATION main expertise resides in the application of Synthetic Aperture Radar (SAR) especially in the field of Interferometric SAR for the monitoring of ground displacements. Its services are provided using its own advanced InSAR processing chain: GlobalSAR™. Since 2010, ALTAMIRA INFORMATION is part of CLS Group. In 2015, ALTAMIRA and T.R.E. join forces and become the largest InSAR group worldwide.
Main tasks in HYEEA project
ALTAMIRA will lead task WP1.2 and task WP1.3
ALTAMIRA contributes to WP6 with its landslide and flood map services
Short profile of key staff member
Laia Romero, female, is Director of New Business & Innovation at ALTAMIRA INFORMATION. Laia Romero was born in Barcelona. She graduated with honors from her BSc in Marine Biology and Oceanography by Fairleigh Dickinson University (FDU, New Jersey) in 2004, where she worked as part of the Natural Science Research group. She later on graduated from an MSc in Research in Physical Oceanography by the Polytechnic University of Catalonia (UPC). In Barcelona, she worked as a science consultant for international companies and coordinated a research team for a private investment group on renewable energies. From 2007, she worked at Starlab, first as a Researcher and Project Manager, gaining extensive experience in technical project management and coordination of EU and ESA projects in the area of Space Technologies & Applications, and then as a Key Account Manager in the EO Services business unit Star2Earth. In 2012, she took up the position of Operational Oceanography and Information Systems Manager at Altamira Information, in close collaboration with its parent company CLS. In 2015 she was promoted to Director of New Business & Innovation at Altamira Information, managing the division that integrates R&D and Data Management Solutions, responsible for the involvement of Altamira Information in institutional projects, new product streamlines, and corporate startegy.

Rubén Iglesias, male, is an Earth Observation Engineer and Project Manager at ALTAMIRA INFORMATION. He was born in Barcelona, Spain, in 1982. He received the B.Sc. and the M.Sc. degree in Telecommunication Engineering from the Universitat Politècnica de Catalunya (UPC), Barcelona, Spain, in 2007 and 2009, respectively. He received his Ph.D. degree from UPC, "Space –borne and ground-based PSI for landslide monitoring".
From June 2009 to June 2010, he was with the Active Remote Sensing Unit, Institute of Geomatics, Barcelona, Spain, working in several projects related with the application of DInSAR to terrain-displacement monitoring with orbital and GB-SAR data. From June 2010 to March 2014, he was with the Signal Theory and Communications Department (TSC), UPC, working as a Research Assistant in the framework of DInSAR and GB-SAR DInSAR applications. In April 2014, he joined the R&D team of Altamira Information.

He has a broad experience in InSAR, DInSAR and PolDInSAR, but also in SAR processing algorithms for Frequency Modulated Continuous Wave (FMCW) radars. In this context, he has participated in several R&D national and international projects related with these topics (such as TERRAFIRMA or SAFELAND). He is the current technical manager of the ESA MEMpHIS project, which is devoted to the study of Earth Observation (EO) technologies for disaster risk reduction and management in areas affected by landslides or tectonics.
He serves as a reviewer for the IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, the IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, and the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING journals.

Relevant publications, products, services (a list of up to 5 relevant publications, and/or products, services - including widely-used datasets or software -, or other achievements relevant to the call content)

R. Iglesias, A. Aguasca, X. Fabregas, J. Mallorquí, D. Monells, C. López-Martínez, L. Pipia, Ground-Based Polarimetric SAR Interferometry for the Monitoring of Terrain Displacement Phenomena. Part I: Theoretical Description and Part II: Applications, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. Volume:8 , Issue: 3, pp980 – 1007. March 2015

R. Iglesias; F. Koudogbo; M. García; O. Mora; P. Blanco; D. Albiol; D. Monells, "Multi-scale Persistent Scatterers Interferometry Approaches for Multi-Hazard Mapping" ESA Living Planet Symposyum 2016, Prague, May 2016

O. Mora; P. Ordoqui; L. Romero, "Generation of classical DInSAR and PSI ground motion maps on a cloud thematic platform" ESA Living Planet Symposyum 2016, Prague, May 2016.

F. Koudogbo; J. Duro; L. Rossi; R. Rudari; A.Eddy, Multi-hazard risk analysis using the FP7 RASOR Platform, Conference: SPIE Remote Sensing for Agriculture, Ecosystems, and Hydrology, Toulouse, Volume: 92390J

L. Romero; López, A.; F. Koudogbo, "Flood extent mapping service in the Hydrology Thematic Exploitation Platform" ESA Hydrospace conference, Rome, September 2015.

Relevant previous projects or activities (a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal)d

LAMPRE (Landslide Modelling and tools for vulnerability assessment Preparedness and Recovery management) FP7 project that executed innovative research and technological developments to increase GMES limited operational capacity to cope with triggered landslide events and their consequences, in Europe and elsewhere. LAMPRE enhances landslide risk mitigation/preparedness efforts and post-event-landslide recovery and reconstruction activities, in highly vulnerable geographic and geologic regions. The project improves the ability to detect/map landslides, assess/forecast the impact of triggered landslide events on vulnerable elements, and model landscape changes caused by slope failures. Products of LAMPRE, including geo-processing tools, landslide inventory/susceptibility maps, vulnerability/impact assessments, and standards and best practices, will be beneficial to Civil Protection authorities, environmental, agricultural and forestry agencies, organizations managing transportation networks, and Emergency Response and Land Monitoring GMES services. ALTAMIRA INFORMATION is involved in EO data processing and technical developments, Research and tools for triggered event landslide mapping, Sustainability and take up and leader of Dissemination. Within the latter, ALTAMIRA INFORMATION is responsible for the Stakeholder User Group of the project.

RASOR (Rapid Analysis and Spatialisation Of Risk) FP7 project that develops a platform to perform multi-hazard risk analysis to support the full cycle of disaster management, including targeted support to critical infrastructure monitoring and climate change impact assessment. RASOR overlays archived and near-real time very-high resolution optical and radar satellite data,

combined with in-situ data for both global and local applications. ALTAMIRA INFORMATION leads the Business Planning and the Service Validation. Furthermore, ALTAMIRA INFORMATION conducts ground motion and flood maps in RASOR test sites, and contributes to the adaptation of the GlobalDEM to the platform, and to the flood risk assessment. ALTAMIRA INFORMATION is also responsible for the QGIS plugins and mobile application to the RASOR platform.

MEMPHIS (Disaster Risk Reduction Using Innovative Data Exploitation Methods & Space Assets) project for ESA**.** Study on how to better exploit and accelerate the utilization of space assets and innovative data exploitation methods such as cloud computing for big data and, secondly, to investigate future space assets (such as for instance future SAR or Optical EO missions) that would be more directly addressing the requirements from scientific and operational users of the Disaster Risk Management sector. ALTAMIRA INFORMATION is the project manager and responsible for the development of adhoc processing chains for ground motion focused on 1. Landslide monitoring and 2. Seismic activity, results from both chain are integrated in advanced landslides and seismic services based on different Earth Observation methods and models.

Hydrology Thematic Exploitation Platform (ESA) provides scientific and institutional stakeholders and practitioners with a flexible web-based platform to access, explore, and exploit EO-based data and products related to IWRM, to support hydrological science, and streamline exchange of geospatial information and knowledge within the relevant user community. This platform will enable EO information products most relevant for Water Productivity and Vulnerability. ALTAMIRA INFORMATION leads the Services Design and Implementation, particularly, it contributes with the services of Flood mapping and small water bodies monitoring from SAR data.

Geohazards Exploitation Platform (ESA), or GEP, aims to support the exploitation of satellite EO for geohazards. It follows the Supersites Exploitation Platform (SSEP), originally initiated in the context of the Geohazard Supersites & Natural Laboratories initiative (GSNL). The geohazards platform has been expanded to address broader objectives of the geohazards community. In particular it is a contribution to the CEOS WG Disasters to support its Seismic Hazards Pilot and terrain deformation applications of its Volcano Pilot. The geohazards platform and SSEP are sourced with elements – data, tools, and processing including INSAR – relevant to the Geohazards theme and related exploitation scenarios. ALTAMIRA INFORMATION provides a ground motion processing chain based on its own SPN proprietary chain to the cloud platfom.

Significant infrastructure and/or any major items of technical equipment

The following section provides a description of the technical equipment owned by Altamira Information that will be relevant to perform the proposed work.

Hardware

- Processing equipment (servers)
  - 4 storage servers (100 TB)
  - 8 processing servers (150 CPU in total)
  - 1 VMWare ESXi server (32 CPU)
  - 1 FTP server (1TB disc)
- Network equipment
  - Gigabit Ethernet network (1000Mbps) with 1 48-port switch and 2 24-port switch
  - 50Mbps internet access
  - Separation of the processing network and the user LAN to guarantee safety and ease the management
- Office equipment
  - 27 working stations with Windows7 and Windows10 (processors i5, i7)
  - 15 laptops
  - 5 laser printers

Software for data processing and handling

- Diapason and Graphical User Interface for SAR data
- Software for data visualisation and for developing data handling tools
- GIS converter and other tools for format conversion
- GIS software for the preparation and visualisation of data and production of deliverables

Reliability of processing facilities

- Redundant storage servers in order to avoid any data loss
- Remote backup system, weekly backup of every working station.
- Quality and Production Control
- Wiki: internal system for production and project collaboration
- Quality Control System: internal tool for the management and review of quality control steps

Data browsers

- EOLI – data browser for ESA/Envisat
- APT – data browser for Radarsat-2
- DLR EOWEB – data browser for TerraSAR-X
- E-Geos - data browser for Cosmo-SKYMed
- JAXA AUIG (ALOS User Interface Gateway) - data browser for ALOS
- Propietary data browser for Interferometry SAR Processing

Management tools

- Microsoft Office (Word, Project, Excel)
- Navision ERP

Simulators

- SAR geometry simulator (enables the detection of areas affected by geometrical distorsions caused by the area topography, i.e. shadow, foreshortening and layover effects).

Internet performance

- 2 FFTH connections 100Mb download, 10Mb upload.

4.2 Third parties involved in the project (including use of third party resources)

No third parties involved.

5. Ethics and Security

5.1 Ethics

We don't have entered any ethics issues in the ethical issue table in the administrative proposal forms.

5.2 Security

Please indicate if your project will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Institute for Environment and Sustainability (Ispra)
Climate Risk Management Unit

Ispra, 21st March 2016
H07-CRM/JT/GB/ (2016)

sent by email
Antonio.parodi@cimafoundation.org

Subject: Letter of support - HYEEA Project - Call EINFRA-22-2016 User-driven e-infrastructure innovation

Dear Dr. Parodi,

It was a pleasure to review, from the perspectives of activities of the Joint Research Centre, an outline of a proposal, entitled HYEEA (Hydro-meteorological e-Infrastructure for Environmental Applications) to develop an e-Infrastructure supporting key European initiatives to meet new challenges in the disaster risk management (DRM) cycle of natural hazards, through the prototyping of innovative data and computing services.

Supporting EU societal challenges with emphasis on natural hazards, such as flash-flood, forest fires and droughts is a very important topic ranging high on the research agenda of the JRC's Climate Risk Management Unit.

With this letter we would therefore like to express our support to the HYEEA proposal in response to the call EINFRA-22-2016 User-driven e-infrastructure innovation. In case successful, the Climate Risk Management Unit would be very interested to follow the progress and outputs of the project and would welcome exchange of information.

Yours sincerely,

Jutta THIELEN-DEL POZO

Head of Unit H07

European Commission, Via Enrico Fermi 2749, I-21027 Ispra (Varese) - Italy. Telephone: (39)0332-78-9111.

This project has received funding from the European Union's Seventh Framework Program for research, technological development and demonstration under grant agreement no. 606888

RAPID ANALYSIS AND SPATIALISATION OF RISK

Dear Dr. Parodi,

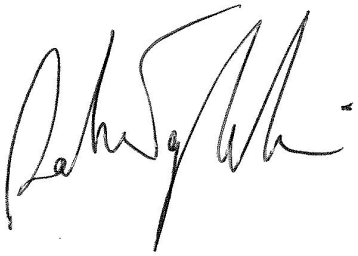
It was a pleasure to review, from the perspectives of activities included in the RASOR (Rapid Analysis and Spatialisation of Risk) Project (www.rasor-project.eu), an outline of a proposal, entitled HYEEA (HYdrometeorological e-Infrastructure for Environmental Applications) to develop an e-Infrastructure supporting key European initiatives to meet new challenges in the disaster risk management (DRM) cycle of natural hazards, through the prototyping of innovative data and computing services, in response to the call EINFRA-22-2016 User-driven e-infrastructure innovation.
The leading idea of this proposal is to support and facilitate the study of natural hazards from their onset to the subsequent social/economic/environmental impacts through the seamless integration of modelling tools and datasets, enabled by state-of-the art modelling and data access services, in a fully-probabilistic multi-model and multi-data e-Infrastructure ecosystem, serving users ranging from profit-making users (e.g. SMEs and innovators), public administration users and research users.
Building on research and operational projects such as DRIHM (Distributed Research Infrastructure for Hydro-Meteorology, www.drihm.eu), RASOR (Rapid Analysis and Spatialisation Of Risk, www.rasor-project.eu), as well as on JRC DRM platforms such as EFAS (www.efas.eu/about-efas.html), EFFIS (/forest.jrc.ec.europa.eu/effis/) and EDO (edo.jrc.ec.europa.eu/), this project will help: supporting EU societal challenges with emphasis on natural hazards, such as flash-flood, forest fires and droughts, prevention and prediction from short-range to up-to seasonal timescale; fast prototyping of innovative DRM computing and intensive services, on top of global e-Infrastructures for the study, evaluation, prediction of severe weather scenarios and their social/economic/environmental impacts; standardisation leading to economies of scale that facilitate access to and uptake of DRM resources and facilitate new inter- and transdisciplinary collaborations between adjacent scientific communities.

It is rewarding to see that you are planning to use the RASOR open platform as a piece of your research infrastructure and the RASOR consortium will strongly support this proposed initiative.

I wish you all success with this project proposal.

Yours sincerely,

Roberto Rudari,
Project Coordinator



Tracy Irvine

Oasis+ Programme Manager,

Department of Physics,

Imperial College London,

Room 1013, Blackett Building,

London SW7 2AZ, United Kingdom

Date: 23rd March, 2016

Dear Dr. Parodi,

It was a pleasure to review, from the perspectives of activities of the OASIS+ Consortium, an outline of a proposal, entitled HYEEA (*HYdrometeorological e-Infrastructure for Environmental Applications*) to develop an e-Infrastructure supporting key European initiatives to meet new challenges in the disaster risk management (DRM) cycle of natural hazards, through the prototyping of innovative data and computing services, in response to the call EINFRA-22-2016 User-driven e-infrastructure innovation.

The leading idea of this proposal is to support and facilitate the study of natural hazards from their onset to the subsequent social/economic/environmental impacts through the seamless integration of modelling tools and datasets, enabled by state-of-the art modelling and data access services, in a fully-probabilistic, multi-model and multi-data e-Infrastructure ecosystem, serving users ranging from profit-making users (e.g. SMEs and innovators), public administration users and research users.

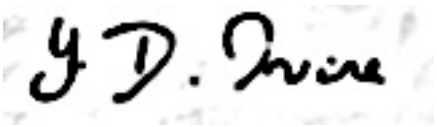
Building on research and operational projects such as DRIHM (Distributed Research Infrastructure for Hydro-Meteorology, www.drihm.eu), RASOR (Rapid Analysis and Spatialisation Of Risk, www.rasor-project.eu), as well as on JRC DRM platforms such as EFAS (www.efas.eu/about-efas.html), EFFIS (/forest.jrc.ec.europa.eu/effis/) and EDO (edo.jrc.ec.europa.eu/), this project will help: supporting EU societal challenges with emphasis on natural hazards, such as flash-flood, forest fires and droughts, prevention and prediction from short-range to up-to seasonal timescale; fast prototyping of innovative DRM computing and intensive services, on top of global e-Infrastructures for the study, evaluation, prediction of severe weather scenarios and their social/economic/environmental impacts; standardisation leading to economies of scale that facilitate access to and uptake of DRM resources and facilitate new inter- and transdisciplinary collaborations between adjacent scientific communities. HYEEA will allow to develop and test new applications and services, particularly

to respond to the growing demand for Climate Services and Products, identified by the WMO Global Framework for Climate Services.

HYEEA modeling and data services can represent a contribution to the OASIS+ activities, in particular the need for accurate data and associated models required to for the most accurate disaster risk assessment and adaptation planning. Equally, the types of tools being developed through this proposal may populate the Oasis Hub, where we are opening a eMarket for data, models, tools and services linked to extreme events, linking demand to supply for this type of data for insurers, municipalities and industry. It should be emphasized that the general thrust of this proposal is highly relevant to the research priorities and work programmes of OASIS+, demonstrating the use of climate risk assessment within a range of sectors. Therefore, I strongly support this proposed initiative.

I wish you all success with this project proposal.

Yours sincerely,



Oasis+ Programme Manager

ARPAL
Agenzia Regionale per la Protezione dell'Ambiente Ligure

Dear Dr. Parodi,

It was a pleasure to review, from the perspectives of activities of the Agenzia Regionale per la Protezione dell'Ambiente Ligure (ARPAL), an outline of a proposal, entitled HYEEA (*HYdrometeorological e-Infrastructure for Environmental Applications*) to develop an e-Infrastructure supporting key European initiatives to meet new challenges in the disaster risk management (DRM) cycle of natural hazards, such as flash-floods, forest fires, and droughts, through the prototyping of innovative data and computing services, in response to the call EINFRA-22-2016 User-driven e-infrastructure innovation.

Building on research and operational projects such as DRIHM (Distributed Research Infrastructure for Hydro-Meteorology, www.drihm.eu), RASOR (Rapid Analysis and Spatialisation Of Risk, www.rasor-project.eu), ESA TEP Hydrology (hydrology-tep.eo.esa.int) and ESA TEP Geohazards (geohazards-tep.eo.esa.int) as well as on JRC DRM platforms, HYEEA project will support and facilitate the study and prediction of natural hazards from their onset to the subsequent social/economic/environmental impacts through the seamless integration of modelling tools and datasets, enabled by state-of-the art modelling and data access services, in a fully-probabilistic multi-model and multi-data e-Infrastructure ecosystem.

Liguria region is historically affected by high-impact weather events associated to torrential rainfall and subsequent flash-flood phenomena, whose frequency seems to be increasing: on November 4th 2011 a synoptic-scale meteorological system was responsible for Genoa city (Liguria, North-Western Italy) being gutted by flash floods that erupted when 450 millimetres of rain – a third of the average annual rainfall – came down in 5 hours (6 dead people). Few days before, on October 25th of 2011, another flash-flood had taken place in Liguria Region, when a freakishly intense rainstorm ripped through the region and inflicted serious damage on the Cinque Terre towns of Monterosso and Vernazza, located on eastern Liguria. Thirteen people lost their lives during this event. On October 9th of 2014, Genoa city center was affected by extreme event, induced by torrential rainfalls in the evening of that day, and causing the death of 1 person and economical damage in order of 100 millions of euro.

Direzione Scientifica – CFMI-PC
Viale B. Partigiane, 2 – 16129 Genova
Tel. +39 010 6437500 - fax. +39 010 6437520
PEC: arpal@pec.arpal.gov.it
nome.cognome@arpal.gov.it - www.arpal.gov.it
C.F. e P.IVA 01305930107

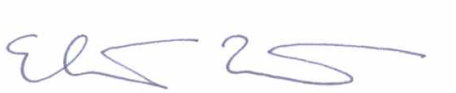
Agenzia Regionale per la Protezione dell'Ambiente Ligure

A deeper understanding of properties of flash-flood producing storms, occurring over complex orography regions and often convective in nature, as well as a probabilistic multi-model and multi-data approach in forecasting these events, are longstanding and important issues in our hydro-meteorology prediction activities, where state-of-the-art data and computing intensive services are becoming crucial.

Then it should be emphasized that the general thrust of this proposal is highly relevant to the operational priorities and activities of ARPAL. In case of successful, ARPAL would be very interested to follow the progress and outputs of the project, therefore, I strongly support this proposed initiative.

I wish you all success with this project proposal.

Yours sincerely,



Dott. Elisabetta Trovatore

Direzione Scientifica – CFMI-PC
Viale B. Partigiane, 2 – 16129 Genova
Tel. +39 010 6437500 - fax. +39 010 6437520
PEC: arpal@pec.arpal.gov.it
nome.cognome@arpal.gov.it - www.arpal.gov.it
C.F. e P.IVA 01305930107

Digitally signed by sealingservice.grants.ec.europa.eu
Date: 2016.03.30 14:38:02 CEST
Reason: Acknowledgment of Receipt

This electronic receipt is a digitally signed version of the document submitted by your organisation. Both the content of the document and a set of metadata have been digitally sealed.

This digital signature mechanism, using a public-private key pair mechanism, uniquely binds this eReceipt to the modules of the Participant Portal of the European Commission, to the transaction for which it was generated and ensures its full integrity. Therefore a complete digitally signed trail of the transaction is available both for your organisation and for the issuer of the eReceipt.

Any attempt to modify the content will lead to a break of the integrity of the electronic signature, which can be verified at any time by clicking on the eReceipt validation symbol.

More info about eReceipts can be found in the FAQ page of the Participant Portal. (http://ec.europa.eu/research/participants/portal/page/faq)