D7.6

Business Plan and Sustainability Report – Issue 1

Instrument	Collaborative Project
Call / Topic	H2020-SEC-2016-2017/H2020-SEC-2016-2017-1
Project Title	Multi-Hazard Cooperative Management Tool for Data Exchange, Response Planning and Scenario Building
Project Number	740689
Project Acronym	HEIMDALL
Project Start Date	01/05/2017
Project Duration	42 months
Contributing WP	WP 7
Dissemination Level	PU
Contractual Delivery Date	M30
Actual Delivery Date	29/12/2019
Editor	Diana Mathew (AVA)
Contributors	Joseph Muna (AVA)

Document History			
Version	Date	Modifications	Source
0.1	01/02/2018	First draft of ToC generated and discussed internally in Avanti	AVA
.0.2	08/03/2018	ToC issued for external review	AVA
0.3	27/09/2019	First draft with updates from review meetings	AVA
0.4	27/11/2019	Draft for QA	AVA
0.5	28/11/2019	QA output	SPH
1.0	29/11/2019	Final issue	AVA
1.0.F	10/12/2019	Final version submitted	DLR

Table of Contents

List of Figures iv
List of Tables v
List of Acronyms vi
Executive Summary 9
1 Introduction 10
1.1 Purpose 10
1.2 Scope 10
1.3 Organisation of the document 10
2 BUSINESS PLAN 11
2.1 Methodology 11
2.2 Lean Canvas Model 11
3 Market Analysis- Problem and Customer Segments 12
3.1 Statistics on natural disasters – an overview 12
3.1.1 Forest Fire 14
3.1.2 Flood 16
3.1.3 Landslide 17
3.2 State of the art on disaster & risk management and alerting 18
3.2.1 Solutions and Initiatives by government bodies 18
3.2.1.1 EU Civil Protection Mechanism 18
3.2.1.2 Climate-ADAPT 19
3.2.1.3 GDACS (Global Alert and Coordination System) 19
3.2.1.4 GFDRR (Global Facility for Disaster Reduction and Recovery) 20
3.2.1.5 ICL (International Consortium on Landslides) 20
3.2.1.6 EU-Alert 20
3.2.2 Systems currently in use 20
3.2.3 Research – past and ongoing 23
3.2.4 Conclusion 27
3.3 Customers 27
3.3.1 Serviceable Addressable Market 27
3.3.2 Early Adopters 29
4 Solution 30
4.1 HEIMDALL Value Chain 30
4.2 Service Packages 31
4.3 Deployment Methods 32
4.4 Service Provider 33
4.5 Benefits and Differentiators 33

5 Financial Analysis 36
5.1 Further development 36
5.2 System deployment cost 38
5.2.1 CapEx 38
5.2.2 OpEx 44
5.2.3 Cost-Benefit Analysis 46
6 Commercialisation and Exploitation Plan 47
6.1 Post-project: Short Term 47
6.2 Post-project: Long Term 48
6.2.1 End-User Organisations 48
6.2.2 Technical Partner Organisations 49
6.3 Standardisation and cooperation with existing projects 50
7 Conclusion 51
8 References 52
9 Annex A: NUTS CLASSIFICATION 55
10 Annex B: Types of Legal Entities 59

List of Figures

Figure 1: Lean Canvas Model 11

Figure 2: Economic damage caused by weather and climate-related extreme event in Europe (1980-2017) [7] 13

Figure 3: Disaster risk types identified by the UCPM participating states [8] 13

Figure 4: Burnt area (a) number of fires (b) and average fire size (c) in the five southern EU member states in 2017 as compared with average values for previous decades [10]. 15

Figure 5: Landslide susceptibility map of Europe [20] 17

Figure 6: Representation of the Nomenclature of Territorial Units for Statistics [22] 28

Figure 7: HEIMDALL Value Chain 30

Figure 8: Schematic diagram showing interdependencies of HEIMDALL products and services 31

Figure 9: Key Benefits of HEIMDALL from questionnaire responses 34

Figure 10: Legal disposition of HEIMDALL consortium 47

Figure 11: Countries in the Member States of the European Union (EU-28; in blue) according to NUTS 2016. 55

Figure 12: NUTS 1 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016 56

Figure 13: NUTS 2 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016 57

Figure 14: NUTS 3 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016 58

List of Tables

Table 1: Example of NUTS classification.....28
Table 2: TRL description as per Horizon 2020 work programme 2014-15.....36
Table 3: TRL of HEIMDALL modules by the end of the project 36
Table 4: Effort for further development.....37
Table 5: HEIMDALL CapEx.....39
Table 6: OpEx of HEIMDALL modules.....44

List of Acronyms

AVA	Avanti Communications LTD
CAP	Common Alerting Protocol
CFRS	Catalan Fire & Rescue Service
CIMA	Centro Internazionale in Monitoraggio Ambientale – Fondazione CIMA (CIMA Foundation)
CPU	Central Processing Unit
CRI	Associazione della Croce Rossa Italiana (Italian Red Cross)
CTTC	Centre Tecnològic de Telecomunicacions de Catalunya (Catalan Tecnological Telecommunications Centre)
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
DRM	Disaster and Risk Management
EC	European Commission
EEA	European Environmental Agency
EU	European Union
FAO	
FBBR	Frederiksborg Brand og Redning (Frederiskborg Fire and Rescue Service)
GB-SAR	Ground based Synthetic Aperture Radar
ICGC	Institut Cartogràfic I Geològic de Catalunya (Catalan Institute of Cartography and Geology)
INT	Departament d'Interior – Generalitat de Catalunya (Catalan Government – Department of Interior)
IPR	Intellectual Property Right
MAV	Micro aerial vehicle
PCF	Fundació d'Ecologia del Foc i Gestió d'Incendis Pau Costa Alcubierre (Pau Costa Foundation)
RAM	Random Access Memory
SFRS	Scottish Fire and Rescue Service
SPH	Space Hellas S.A.
TSYL	Tecnosylva S.L.
UNISTRA	Université de Strasbourg (University of Strasbourg)
UNISDR	United Nations Office for Disaster Risk Reduction

UNOSAT	United Nations Operational Satellite Applications Programme
VSAT	Very Small Aperture Radar
WMO	World Meteorological Organisation

Intentionally blank

Executive Summary

This deliverable forms part of the work carried out under ***Task 7.3: Legal, Organisational Framework and Business Plan*** of HEIMDALL project. This report is the first version towards developing a sustainable business plan for the IT-based system being developed under HEIMDALL project. This deliverable captures the outcomes in relation to discussions within the consortium regarding their plans to developing the modules/products of the system to a fully operational stage and building a roadmap towards a self-sustaining enterprise to offer the HEIMDALL services.

Natural and man-made disasters affect thousands of lives, economy and environment each year globally. Exacerbated by climate change, these events are becoming more frequent, extreme, and complex and sometimes even reaching across national borders. Adequate equipment and tools, training and inter-working between emergency services and first responder agencies are necessary to ensure these actors are well organised to anticipate and provide timely and efficient response to such disaster situations. Several programmes are underway on a global and regional scale to address these gaps. HEIMDALL aims to create a modular IT-based prototype system, focusing on disaster events – Forest Fire, Flood, Flash Flood and Landslide, offering services mainly in the preparedness and response phases of disaster and risk management. HEIMDALL system has been designed to be used by these agencies for training, inter-organisational and cross-border operations as well.

This deliverable consolidates the alternative solutions available in the DRM sector, costs and efforts estimated to bring the prototype to an operational level, way forward envisaged by the consortium post-project and the methodology that has been followed to capture these details. An updated version of this deliverable, the final deliverable under Task 7.3, D7.7 will be submitted in M42 [1].

1 Introduction

1.1 Purpose

This deliverable is the first report due under Task 7.3 – *Legal, Organisational Framework and Business Plan* of the HEIMDALL project. This document captures the information required to develop a sustainable business plan for the products and services developed under the project and the collective plan of the consortium to reach that goal.

1.2 Scope

This document initially captures the impact of the hazards considered by HEIMDALL system – forest fire, flood, flash flood and landslide. Results consolidated on the effect of these hazards on the population, environment and economy is presented. Europe, including the UK, is assumed the main region of interest for HEIMDALL even though the system can be adapted for other regions and countries around the world. This information is complemented with details about the efforts/initiatives being considered at the regional and national level in the area of disaster management and alerting. Additionally, a brief overview of research activities looking into bridging the gaps within DRM sector is presented. This information has mainly been gathered from the end-users and technical partners of the consortium and from the interviews with personnel from emergency services and first responder organisations outside of the consortium.

The HEIMDALL platform is modular. This modular structure allows the services to be tailored to the needs of the customers. Based on the various products (modules) developed within HEIMDALL, an overview of how the products interconnect and what service package combinations are possible is presented in this deliverable. HEIMDALL consortium comprises of partners from both academia and industry, with different internal processes on product commercialisation. Bearing in mind the feedback from the commission and the legal disposition of the consortium members, we have presented the best possible solution agreeable to all partners to ensure further development and sustainability of HEIMDALL services. Also included is some preliminary information on the costs involved for further development.

1.3 Organisation of the document

The rest of the document is organised as follows:

Section 2 explains the methodology adopted to compile the business plan for HEIMDALL.

Section 3 identifies the needs and gaps in the disaster and risk management market, especially in relation to forest fire, flood, flash flood and landslide. Also presented are the solutions currently available or being developed, customer segments and early adopters.

Section 4 explains the services offered by the HEIMDALL system along with its unique key benefits.

Section 5 provides preliminary details about the capital and operational expenses of the system

Section 6 discusses the strategy being considered by the consortium for the post-project phase of the project to ensure continued development and sustainable revenue generation.

Section 0 concludes this deliverable report.

2 BUSINESS PLAN

2.1 Methodology

Among the various business plan models, lean canvas model is becoming a more popular choice especially for putting together a plan for start-ups. We have adopted this methodology to put together our objectives and plans to formulate a sustainable business model for HEIMDALL. The Lean Canvas [2] has been adapted from the Business Model Canvas proposed originally by Alexander Osterwalder [3]. This lean version has been adapted in such a way that it allows easier modifications as the business progresses.

2.2 Lean Canvas Model

As shown in **Figure 1**, the Lean canvas model allows putting together all the key elements about the product, market and finances of a new business in a single page structure. It can be updated as and when needed to tailor the growth of the business. The numbering indicated is a recommendation on the sequence to fill in the model but is not mandatory to follow this order. In this document, we use the lean canvas model as a template but explain the elements of our plan in detail, as in a traditional business plan document.

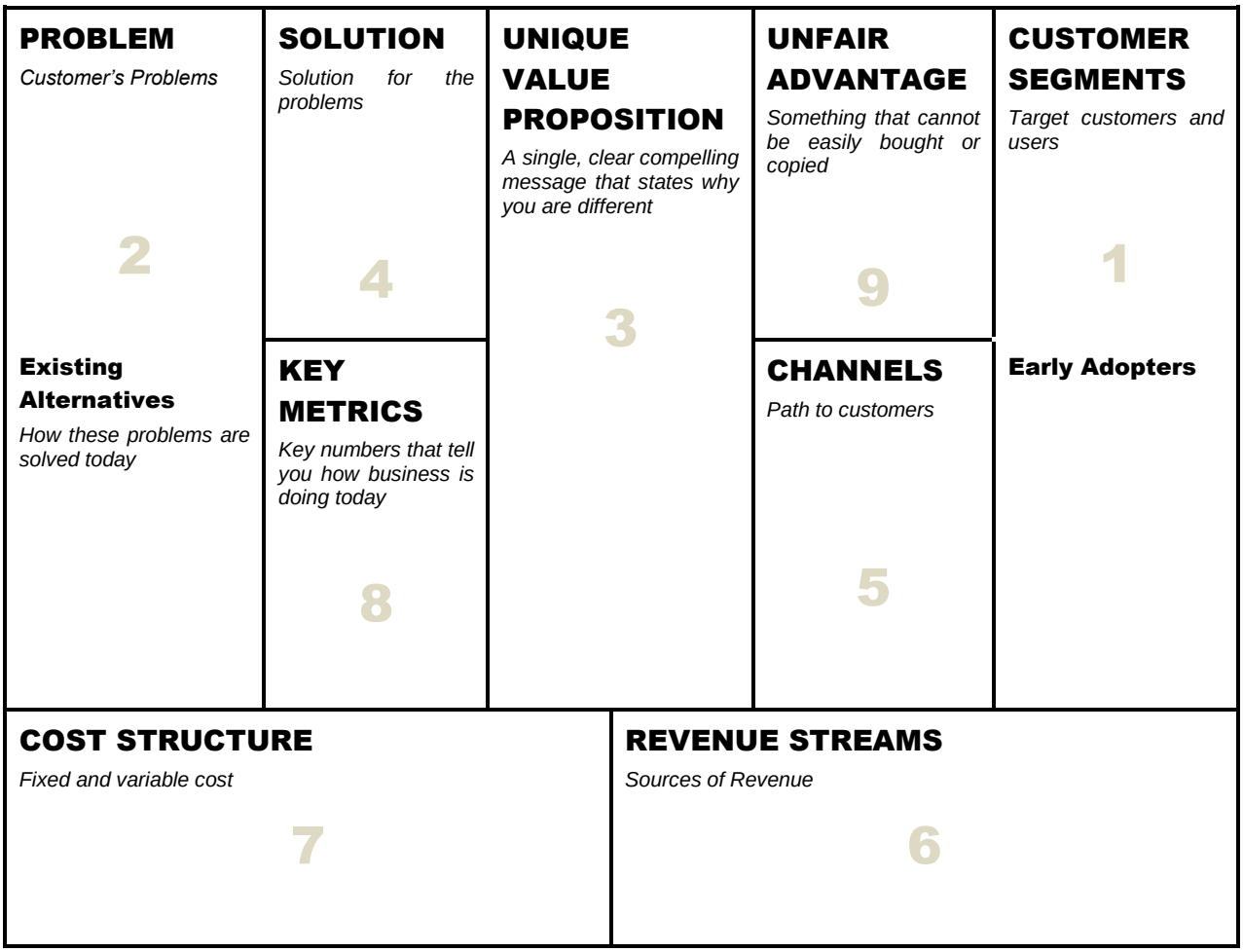

Figure 1: Lean Canvas Model

3 Market Analysis- Problem and Customer Segments

Globally, natural and man-made disasters affect thousands of lives, economy and environment each year. Exacerbated by climate change, these events are becoming more frequent, extreme and complex, sometimes even reaching across national borders. This section takes a closer look into the disaster and risk management market segment that HEIMDALL addresses, progressing on to the potential market and early adopters identified for the system. HEIMDALL addresses three main hazard types – forest fires, floods (including flash floods) and landslides.

3.1 Statistics on natural disasters – an overview

This section provides an overview of the natural disasters that have occurred in Europe and elsewhere to establish the context of the system being developed under the HEIMDALL project. According to the European Environment Agency (EEA), the 33 European Economic Area countries have experienced a collective loss of €13bn a year since 2010 due to climatological and geophysical events. Germany, Italy, France and the UK topped the list of countries of most hard-hit damages. Nearly a third of the total economic losses were caused by flood damage and another third by storms. **Figure 2** illustrates recent data on the economic damage caused by weather and climate-related extreme events in Europe. From the available studies, in addition to climate changes such as increased heavy precipitation, the observed increase in economic losses from river floods and storms in Europe can be attributed to increasing in populations, economic wealth and developments in hazard-prone areas. According to the United Nations and World Bank reports, more than 2/3rd of the worlds' population will live in cities by 2050. It is estimated that this rapid urbanisation could put 1.3 billion people and $158 trillion in assets at risk to the river and coastal floods. These figures do not factor in the impacts of climate change on hazard intensity and frequency. Climate change is expected to bring more frequent extremes in rainfall, triggering more droughts and floods, and rise in sea level resulting in floods in many coastal areas [4].

Details of hazards in the past can provide valuable lessons to help governments and institutions to understand the impacts similar events would have if they happen in today's more populous world. Having the ability to model hazards and possible response and rescue operations would help authorities to better prepare its emergency response services and increase the resilience of communities. In addition to immediate economic losses such as damage to buildings and other infrastructure, natural hazards usually have longer-lasting impacts such as loss of health care and educational facilities, and loss of livelihood, leading to poverty in economically backward countries. In this sense, the World Bank considers disaster risk management as a positive step towards poverty reduction [5]. As pointed out in the European Commission Guidelines for Risk Assessment and Mapping and the objectives of the Sendai Framework for Disaster Risk Reduction [6], managing disaster risks efficiently requires an all-hazards and multi-risk approach.

As shown in **Figure 3**, from the National Risk Assessment carried out by the countries participating in the Union Civil Protection Mechanism (UCPM) set up by the European Parliament, flooding and forest fires rank in the top three disaster risk types.

Disasters can happen irrespective of national borders. Events affecting border regions may face a combination of obstacles - the vulnerability of natural border environments, insufficient resources on a national scale and/or legal/administrative obstacles. Even though a few cooperative initiatives are in place in some regions of Europe, these are either hazard-specific or are not reflected in the risk assessment, risk management planning and response planning processes at the national level. Hence, gaps exist in the assessment and planning of such risks, complementing and supporting the work of competent authorities at national or regional levels

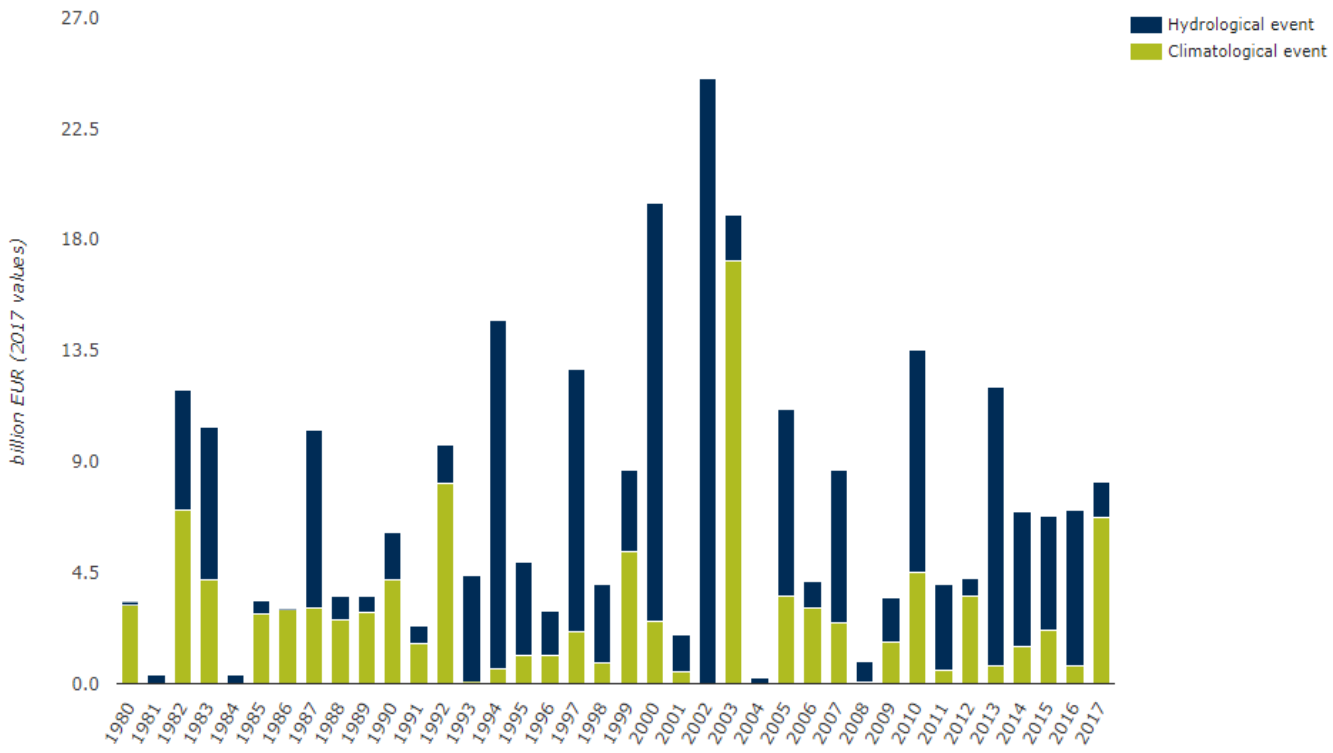

Figure 2: Economic damage caused by weather and climate-related extreme event in Europe (1980-2017) [7]

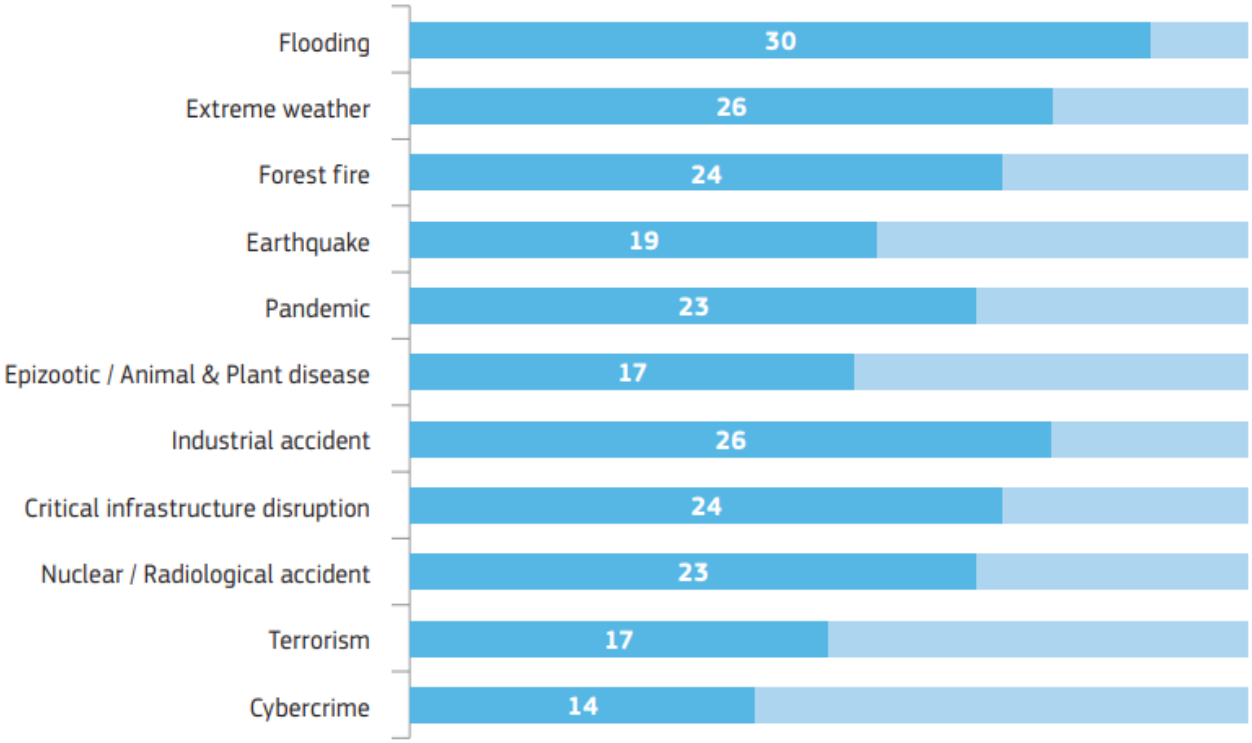

Figure 3: Disaster risk types identified by the UCPM participating states [8]

3.1.1 Forest Fire

With the recent climate changes, forest fires are becoming more frequent and damaging. At the time of preparing this report, in 2019 alone, over 1600 wildfires have been reported in the EU, over three times higher than the average number in the last decade. According to the report from the Copernicus' EFFIS (European Forest Fire Information System), there have been more wildfires burning more land in Europe in the first part of 2019 that in the whole of 2018 [9]. This increasing trend has been partly due to the heatwaves in the continent and partly due to the dry winter across Europe. Studies show that due to climate change, Europe is expected to see drier weather in the coming years, increasing the risk of wildfires and longer fire season. From the latest report published by the European Commission on Forest fires, wildfires destroyed over 1.2 hectares of forests and land in Europe, an area more than the total surface of Cyprus, and claimed 127 lives. Economic damage caused by these fires in Europe has been estimated to be about 10B euros. **Figure 4** shows a comparison from the report of forest fires in the fire-prone 5 European southern states in 2017 with that of since 1980. It can be seen that despite the increase in the number of fires has been marginal, area burned has increased significantly [10].

EFFIS and EU's Copernicus observation system are among the tools used by the EU member states to monitor wildfires and issue recommendations. EFFIS complements national databases and aims to provide EU level assessments of situations before and after fires, to support fire prevention through risk mapping, and to promote preparedness, firefighting and post-fire evaluations.

In relation to Forest fire risk reduction and management, certain key areas identified and discussed in policy-making at EU level are [11]:

- Land, aerial and space detection is essential for timely and accurate detection of fire behaviour, for coordinating efforts at strategic and tactical levels and preforming a quicker and stronger attack.
- With the increased intensity and occurrence of wildfires, there is a strong need for training and education for firefighters. Common Incident Command Systems and common standards on capacity building for emergency training at the European level are needed for enhancing international firefighting assistance.
- As decision-making relating to safety concerns is delicate and complex, strong cooperation and the exchange of experiences and lessons learned in Europe and worldwide are necessary in order to be in a position to recommend new options in the area of fire safety.
- Standardisation of response measures, firefighting equipment and techniques is also needed to make efficient use of the technologies and knowledge available.
- National wildfire legislation and policies differ among EU Member states according to varying risk exposure and management strategies, political leadership, stakeholder involvement and also because of the different government agencies responsible for fire risk management. This multilevel governance structure in wildfire management calls for effective coordination and influence of the activities of the multiple organisations at from national to local level.
- Improving transparency, adequate information dissemination, knowledge integration and citizens' participation have been identified as steps to improve governance mechanisms within forest fire management. To make the best use of the innovations delivered by the research projects, efforts should be dedicated to improving knowledge transfer to practitioners and decision-makers.

Overall, since 2002, the EU has mobilised over €142 million in financial assistance to respond to forest fire disasters in Europe.

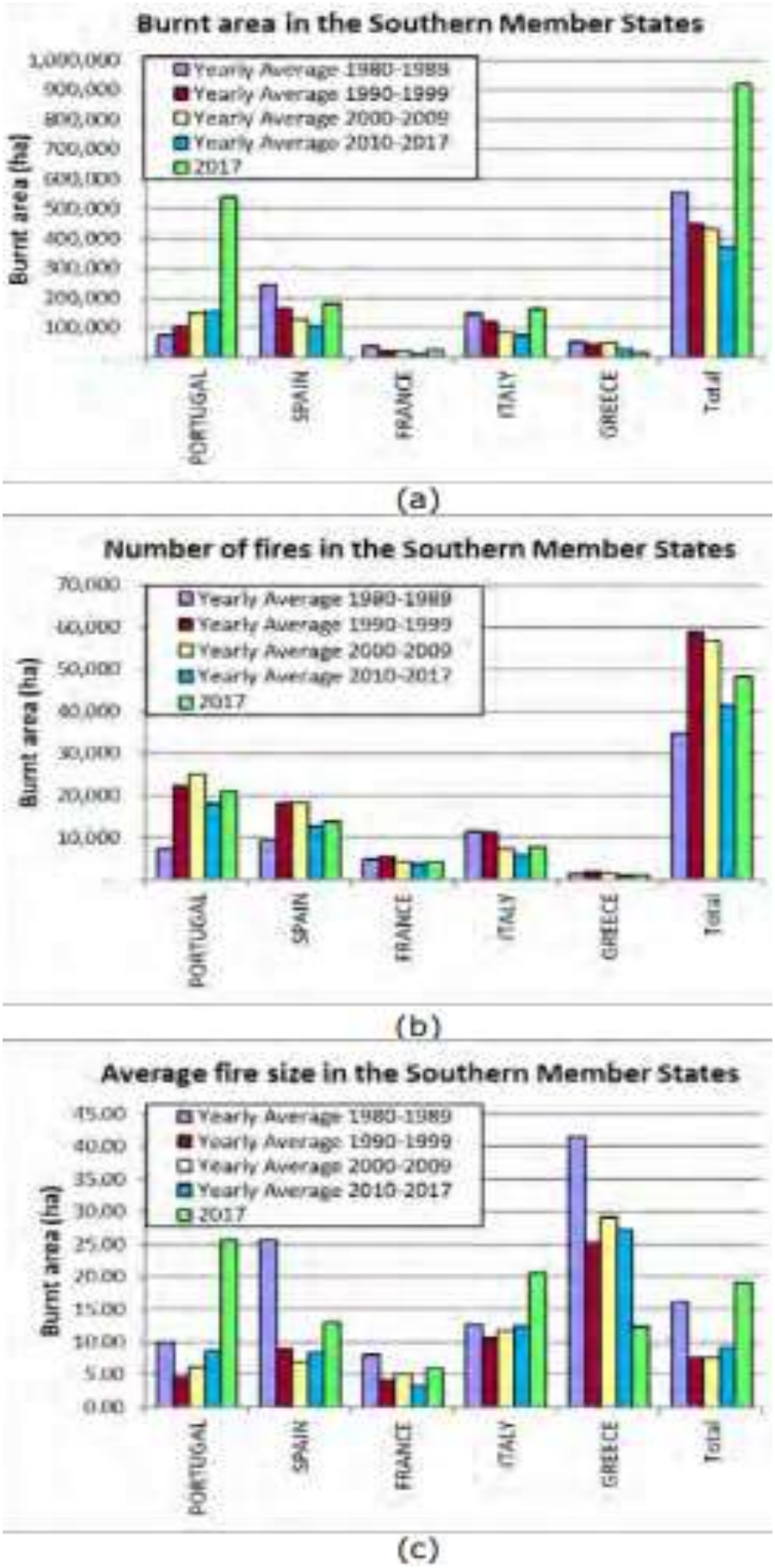

Figure 4: Burnt area (a) number of fires (b) and average fire size (c) in the five southern EU member states in 2017 as compared with average values for previous decades [10].

3.1.2 Flood

Flooding has been reported as the main risk faced by the emergency management authorities in Europe [12]. With increased global warming, sea levels are on the rise. This is becoming a cause of concern for coastal areas where flooding is expected to become more frequent. Flood events can also take the form of river, flash and water surface floods. Recent studies have shown that the number of large flood events has increased over the years [13]. As climate change advances and urban settlements expand into flood plains, uncertainties surrounding flood risk management requires constant monitoring and adjustment of practices to ensure lowest possible damage. In terms of economic losses, a number of recent major flood events across Europe - in Greece (Central and Evros regions; 2015) and in Croatia, Serbia and Romania (2014)- estimated to about EUR 400 million and over EUR 1.5 billion, respectively. Overall, the EU has mobilised over €1.9billion in financial assistance in response to flood events since 2002 [14]. In 2019 alone, unprecedented heavy flooding and flash flooding caused by heavy rain has been reported in UK, Spain, France, Italy and Greece [15]. In the wake of large floods along Danube and Elbe rivers in 2002, the European Commission introduced the Floods Directive, which sets a framework for reducing the risks of flood damage within the EU [16]. In addition to economic and social damage, floods can have severe environmental consequences, for example, when installations holding large quantities of toxic chemicals are inundated. The coming decades are likely to see a higher flood risk in Europe and greater economic damage.

However, Hydrogeological Risk Management practice within Europe varies widely, mainly because:

a) The entity of the hydrogeological risk is different in different countries

b) The nature and quality of available data is not uniform

c) Social attitudes vary among countries

Under the European Flood Directive, member states are required to create individual Flood risk management plans. Flood risk management is an integral part of integrated river basin management, and aim to reduce the likelihood and/or the impact of floods. Under the directive, the member states are required to coordinate with each other in transboundary river basins. Member States with transboundary river basins are required to develop common approaches, taking account, at the basin scale, of the upstream and downstream effects of flood risk reduction measures not located near national borders and extend the practice of international public consultations [17]. It is found that these programs are most effective if incorporating the following elements:

- **Prevention**: preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land-use, agricultural and forestry practices;
- **Protection**: taking measures, both structural and non-structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
- **Preparedness**: informing the population about flood risks and what to do in the event of a flood;
- **Emergency response**: developing emergency response plans in the case of a flood;
- **Recovery and lessons learned**: returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population

Severe flooding is a recent occurrence in many European countries and hence in terms of preparing a community about a potential flooding event via early warning and advice messages, and tackling a flood event effectively, emergency agencies and authorities are under-equipped. However, things are improving; for example, Environment Agency in England has implemented a new service of issuing flood alerts to public via Google services. This service, which came into effect in August 2019 [18], will allow flood warnings to appear on people's personal devices, via

Google Search and Google Public Alerts map, in a matter of seconds once they have been issued. This service is already available in the USA, South America, parts of Asia and Germany via the Public Alerts service made available by the philanthropic arm of Google, *Google. Org* [19].

3.1.3 Landslide

Landslides are a major factor of landscape evolution in mountainous and hilly regions in Europe. **Figure 5** highlights areas prone to landslides based on geology: slope, land cover and land use. Factors that can trigger landslides (such as rainfall, seismicity, snowmelt, volcanic eruptions and human actions) are not considered here to assess susceptibility. Landslides occur in many different geological and environmental settings across Europe. Intense and/or long lasting rainfall represents the most frequent trigger of landslides in continental Europe. However, earthquakes and human activities are also the cause of many slope failures in infrastructure and built-up areas. In more recent years, population growth and expansion into landslide-prone areas is raising landslide risk in Europe. In addition, an increase of landslides associated with extreme rainfall events is expected in the future due to climate change. Landslides, because of the huge amount of earth displaced, has the potential to cause floods. These cascading events, to be contained effectively, need advanced mapping and simulation capabilities. Most statistics on natural disasters underestimate the impacts from landslides as they often do not separate them from other triggering or concurrent natural hazards such as storms, floods or earthquakes [21].

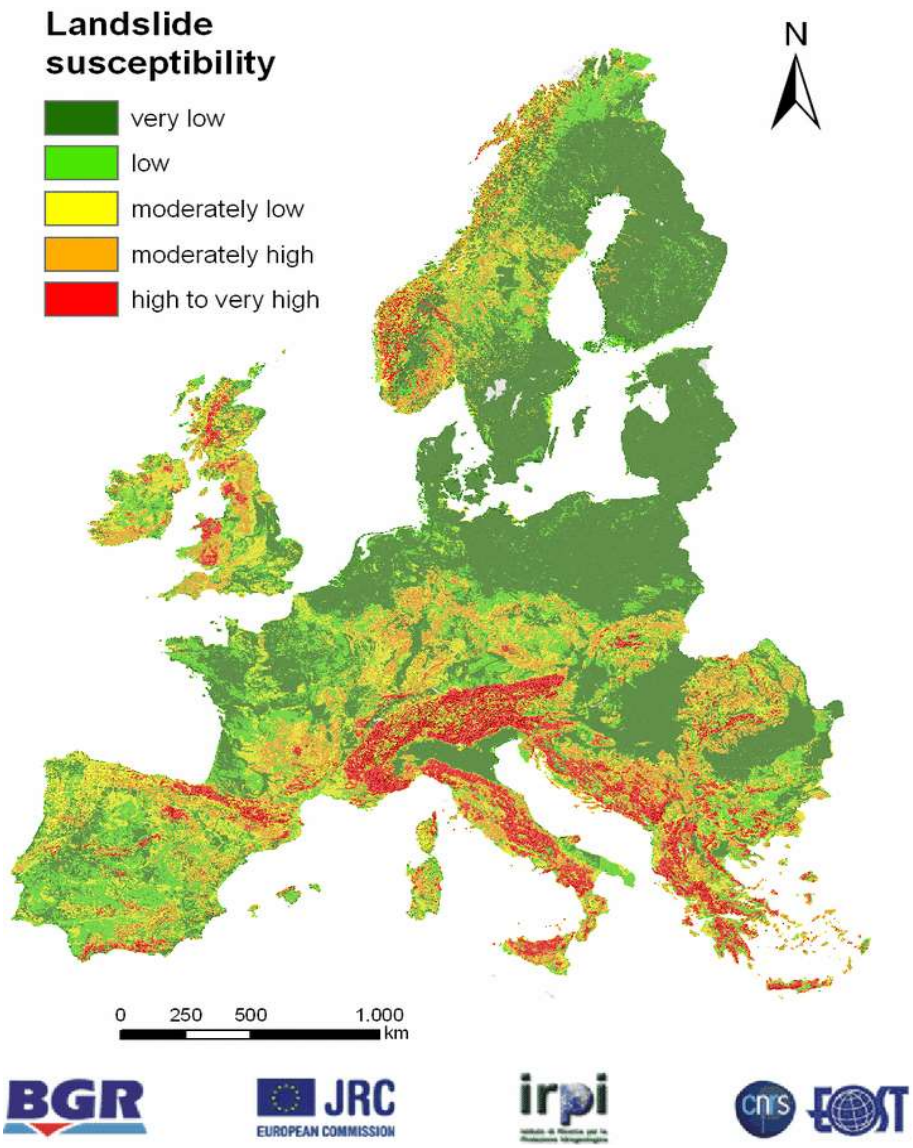

Figure 5: Landslide susceptibility map of Europe [20]

3.2 State of the art on disaster & risk management and alerting

Multiple natural disasters have affected all parts of the EU in recent years, causing hundreds of casualties and billions in damage to infrastructure. Governments and other organisations, at an international and regional scale, with the aim of providing the first responder organisations with tools to improve their capabilities and strengthen the cooperation between different agencies, are considering a number of initiatives. This section provides a high-level overview of the programmes and systems currently available to forecast and take proactive measures in disaster and risk management and alerting as well as provide an improved and effective response to any natural and man-made hazard. A high-level overview of closely related research projects in the sector, funded by the Commission in the recent past and present, is also presented.

3.2.1 Solutions and Initiatives by government bodies

3.2.1.1 EU Civil Protection Mechanism

The European Commission initiated the Civil Protection Mechanism [2] in 2001 with an aim of strengthening the cooperation between the EU members and participating states in the field of civil protection and thus improving prevention, preparedness and response to disasters. A joint approach helps to pool expertise and capacities of first responders avoid duplication of relief efforts and ensure that assistance meets the needs of those affected. Even countries outside of the European Union can request support if needed.

The Emergency Response Coordination Centre (ERCC) is the operational hub of the mechanism, mobilising assistance and expertise when requested. It also has the capability to monitor events around the globe 24/7 and can provide rapid deployment of emergency support within and outside Europe. It provides emergency communications and monitoring tools through the Common Emergency Communication and Information System (CECIS), a web-based alert and notification application enabling real-time exchange of information.

The satellite-based imaging services of the Copernicus Emergency Management Service (EMS) [24] can also be utilised from within this mechanism. The Copernicus EMS provides timely and precise geospatial information, at the request of authorised users, which is useful to delineate affected areas and plan disaster relief operations. Two main components of this service are Early Warning and Mapping, including Rapid Mapping and Risk & Recovery Mapping. Within the Rapid Mapping portfolio, which is a 24/7/365 operational high-speed service, geospatial information products are made available in less than 12 hours after satellite imagery reception.

The Civil Protection mechanism also runs an active and comprehensive training programme for experts from across Europe to improve their coordination and assessment skills in disaster response.

3.2.1.1.1 EFFIS (European Forest Fire Information System)

Created in 1998, EFFIS [25] aims to provide harmonised information on forest fires and assessment of their effects in the pan European region. As of 2015, EFFIS has been adopted as one of the components of the EU Copernicus Program, which provides a legal and financial basis for its operation under this framework. It consists of a network of EU and non-EU and MENA countries. The fire warning, hazard mapping and monitoring services provided by EFFIS are comparable to the earth observation products of HEIMDALL.

3.2.1.1.2 EFAS (European Flood Awareness System)

Started as a research study for a European scale flood forecasting system by the Joint Research Centre of the European Commission in 1999, EFAS [26] became part of the Copernicus EMS in 2011 and has been fully operational since 2012. EFAS is the first operational European system

monitoring and forecasting floods across Europe. The aim of EFAS is to support preparatory measures before major flood events strike, particularly in the large trans-national river basins and throughout Europe in general. This Early Warning component of the Copernicus EMS provides its partners **-** national/regional authorities, ERCC - with a wide range of complementary, added-value information such as probabilistic, medium-range flood forecasts, flash flood indicators, including related risk assessments, up to 10 days in advance.

The ERCC (Emergency Response Coordination Centre), coordinates civil defence response to disasters at the European level and, through its Copernicus EMS, forewarns civil protection agencies of up and coming disasters. HEIMDALL, in comparison, is a systematic and integrated dynamic scenario-based platform providing a more complete user experience at a regional level. HEIMDALL supports strategic planning in the preparedness phase and, in the response phase, adds simulation, impact assessment and decision support services. Earth Observation products available via Copernicus services can be used as an external data source for HEIMDALL. Alternatively, information available from HEIMDALL can be fed to the ERCC and Civil Protection Mechanism.

3.2.1.1.3 ***rescEU***

To strengthen the EU's collective response to disasters like major wildfires and floods, *rescEU* [27] entered into force on March 21, 2019. *rescEU* is a reserve of assets used when Member States can't cope with a disaster themselves and require extra EU assistance to be delivered quickly. All costs and capacities of *rescEU* are fully covered by EU financing, with the European Commission retaining the operational control of these assets and deciding on their deployment. The *rescEU* initiative upgrades the EU Civil Protection Mechanism, establishing a new European reserve of capacities – firefighting planes and helicopters, special water pumps, urban search and rescue and field hospitals and emergency medical teams – while boosting disaster prevention and preparedness measures.

3.2.1.2 Climate-ADAPT

Climate-ADAPT [28]*,* the European Climate adaptation platform, has been created in partnership between the European Commission and the European Environmental Agency. This platform aims to support Europe in adapting to climate change by helping users to access and share data and information on:

- Expected climate change in Europe
- Current and future vulnerability of regions and sectors
- EU, national and transnational adaptation strategies and actions
- Adaptation case studies and potential adaptation options
- Tools that support adaptation planning

3.2.1.3 GDACS (Global Alert and Coordination System)

GDACS [29] is a cooperation framework between the United Nations and the European Commission. It includes disaster managers and disaster information systems worldwide and aims at filling the information and coordination gaps in the first phase after major disasters. It provides real-time access to web-based disaster information systems and related coordination tools. Disaster information tools and online coordination tools currently provided include:

- **Disaster alerts**: Issued to about 25000 subscribers immediately after sudden-onset of disasters. The Joint Research Centre of the European Commission provides the estimates and risk-analysis that form the basis of the alerts.

- **Virtual OSOCC**: Managed by the UN's Office for the coordination of Humanitarian Affairs (OCHA), this restricted online platform allows real-time information exchange and cooperation among all actors in the first phase of a disaster.

- **Maps and satellite imagery**: Facilitated by the UN Institute for Training and Research's (UNITAR) Operational Satellite Applications Programme (UNOSAT), this service allows organisations to monitor and inform stakeholders of their completed, current and future mapping activities during emergencies. Maps and images from various providers are shared in the Virtual OSOCC through the GDACS Satellite Mapping and Coordination System (SCMS).

GDACS information is openly accessible through the GDACS platform interfaces. Data and estimated impact can be directly integrated into other web portals or websites through RSS feeds or other standard formats. In comparison to HEIMDALL, GDACS is a platform used in the disaster response phase and can be employed as a complementary external information system for HEIMDALL.

3.2.1.4 GFDRR (Global Facility for Disaster Reduction and Recovery)

GFDRR [30] is a global partnership led by the World Bank that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change. Under this initiative, various tools are being developed to allow decision-makers and communities to collect, share and understand risk information. Working with more than 400 local, national, regional, and international partners, GFDRR provides grant financing, technical assistance, training and knowledge sharing activities to mainstream disaster and climate risk management in policies and strategies. Managed by the World Bank, GFDRR is supported by 34 countries and 9 international organizations. The EU is a key partner of GFDRR and one of its biggest donors.

3.2.1.5 ICL (International Consortium on Landslides)

The ICL [31] is an international non-governmental and non-profit making scientific organisation supported by UNESCO, UN/ISDR, FAO, WMO and intergovernmental programmes. It promotes landslide research for the benefit of society and environment and coordinates collaborative research and expertise, as well as capacity building on landslide disaster risk reduction.

3.2.1.6 EU-Alert

Under the new directive adopted by the Council of the European Union on European Electronic Communications Code (EECC), all EU member states will have to set up a public warning system to protect citizens. This system will send alerts to all citizens and visitors' mobile phones in a specific area in the event of a natural disaster, terrorist attack or another major emergency in their area. The mandatory implementation of the public warning system will have to be in place by 21 June 2022 for each EU member state [32].

3.2.2 Systems currently in use

This section provides a brief overview of the IT system/tools either in-use or being developed for end-user partners of HEIMDALL and/or known to the consortium.

- **Systel** [33]: A leader in the Systems and Telecommunications market for Departmental Fire and Rescue Services. In many regions of France, the French emergency organisations have this solution in place to support firefighters. A customised system is being built for the Scottish Fire and Rescue Service (SFRS).

- **Assign** [34]**:** An IT system from *Order Group*, based in Denmark. The system allows for optimization of the daily operation, an overview of the quality the organization provides and the possibility for easy and quick communication with the employees. The system is

developed by people with training and operational experience from fire and ambulance services and is developed based on their own experiences with daily operations. FBBR has a system, under development, on a yearly licence basis, aimed mainly for response phase of operations.

- **LCMS** [35]: It is a nation-wide crisis management system used in The Netherlands to maintain and share a common operational picture. LCMS is a web-based collaboration environment that supports making clear agreements about sharing information based on an up-to-date, consistent and common operational picture. It supports maintaining and sharing geographical as well as textual pictures.

- **Mission Planner** [36]**:** An open-source system that allows planning routes for a single UAV and takes pictures along the route. There is no processing of the pictures. In comparison, HEIMDALL drones' system can plan for multiple UAVs and is tailored to detect hotspots.

- **PIX4D** [37]**:** It is a commercial system similar to *Mission Planner* but, in addition, *PIX4D* offers a feature to process the data offline to create a geo-referenced mosaic or 3D model from the pictures. This last functionality can also be used by HEIMDALL system in post-processing.

- **DEWETRA** [38]: A fully operational platform used by the Italian Civil Protection Department and designed by CIMA Research Foundation to support operational activities at the national or international scale. The system is a web-GIS platform aimed to multi-risk mapping, forecasting and monitoring. Using the tools of the platform, it is possible to aggregate data both in a temporal or spatial way and to build scenarios of risk and damage. The World Meteorological Organization (WMO) has signed a cooperation agreement with the Italian Civil Protection Department in order to install and deploy *DEWETRA* in countries requesting it through WMO.

- **Cellnex** [39]: A system that is being developed by telecom infrastructure provider *Cellnex* that would allow sending messages to the population and knowing if they have been evacuated and if they have reached the meeting point. It has received much interest from the local municipalities and local police forces in Spain as is expected to help better manage the emergencies and be aware of its population.

- **ESRI ArcGIS** [40]: The platform of *ESRI ArcGIS ONLINE* together with *Collector App* (see below) allows the users to use interactive maps to collect on-field information during incidents. This platform allows analysing this data and to obtain a catalogue of incidents along time to widen the knowledge of the fire behaviour. Moreover, it helps the users to manage operational information and to send this information to firefighters in an easy and fast way. Catalan Fire and Rescue Service (CFRS) is trialling it at present. The tool allows them:

    - To do a simultaneous analysis between the different participants in an incident.

    - To obtain the support of an expert not directly involved in the incident. This way it is possible to obtain an external opinion from wherever the world about the fire ongoing in Catalonia in order to support the Fire Analyst.

    - To have an occult web available with information directed to the public to use when necessary to share information in real-time. Although available, not used by CFRS at present.

    - To have the options to visualize satellite imagery in the platform in real-time that allows overlaying other information, e.g. vehicles in the area.

Among the products that end-users commonly use, ArcGIS was mentioned quite frequently. Also mentioned was **QGIS** [40] - a free and open-source geographic information system.

- **Collector** (App for ArcGIS) [41]**:** *Collector* is a mobile application, available on Android, iOS and Windows, that allows the user use maps anywhere to ground-truth the data, make observations, and respond to events. It helps to improve the efficiency of the workforce and the accuracy of the information. *Collector* app allows the user to:

    - Collect and update data using the map or GPS
    - Download maps to devices and work offline
    - Collect points, lines, areas, and related data, e.g. of firefighter manoeuvers, fire perimeter, extinguished part of the perimeter, firefighter's location, trucks' location, etc.
    - Fill out easy-to-use, map-driven forms
    - Attach photos to the features
    - Use professional-grade GPS receivers
    - Search for places and features
    - Track and report their locations
    - Integrate with *Navigator* for ArcGIS
    - Integrate with *Workforce* for ArcGIS

In comparison to HEIMDALL, the ESRI tools do not allow collecting lessons learnt, obtaining a response plan or using simulators. However, from the point of view of a geographical information system, the *Collector* app offers an easy and practical way to collect information and to send information to the firefighters on the field. Moreover, it allows the expert user to analyse the potential fire behaviour based on the information collected from the field.

- **SIGB** [43]**:** It is a geographical information system developed and used by the Catalan Fire and Rescue Service (CFRS) in its command rooms to visualize and show the geolocation of incidents, resources and crew. It is multi-hazard, with capabilities to be used in hazard events such as Forest Fire, Flood, Flash Flood, Earthquake and Avalanche. It has access to meteorological and hydrological information via Catalan weather service and to the critical infrastructure database, updated every week, via the Fire service. In comparison to HEIMDALL, this system does not have provisions to run simulations, collect lessons learnt or create response plans. However, it provides highly detailed cartography.
- **Dispatch** [43]: It is a platform shared by the different CFRS Command Rooms, which when combined with the SIGB mentioned above, allows visualising the geolocation of incidents, resources and crew. It has been developed internally exclusively for CFRS. In comparison to HEIMDALL, it is a platform focused on dispatching resources and its aim does not include analysing the incident but keeping track of the crew working on an incident, the manoeuvres (e.g. aerial mean water discharges) and the information that reaches the Command Room.
- **Mycelium – Fénix** [43]: A new management system under development that improves coordination and allows sharing data and information with other services/groups/actors. Used so far in the (Catalan) Joint Command Room to better coordinate the actions between firefighters, emergency services and police forces (Local Police of Barcelona and the Catalan Autonomous Police- Mossos d'Esquadra). There are still some difficulties in sharing all the information, for example, layer to place critical infrastructures.
- **Sigme** [43]: A geographical information system (GIS) currently used by the Catalan Autonomous Police- Mossos d'Esquadra.
- **OruxMaps** [44]: An android application that can display OpenStreetMap maps (raster tiles and vector maps) and has tracking and waypoint recording features, making it suitable for gathering data. It can use offline vector maps or display map tiles online or pre-downloaded from a variety of sources. It can also display 3D views of maps.

- Wildfire Analyst pocket [45]: A mobile application, developed by Technosylva, which provides instantaneous calculation of fire behaviour based on the inputs and parameters selected by the user.
- **Propagator** [46]**:** A web application, developed by CIMA under *ANYWHERE* project, providing probabilistic forecasts of the Spatio-temporal distribution of (forest) fire spread after ignition. In comparison, the forest fire simulator implemented in HEIMDALL, developed by Technosylva, is based on Wildfire Analyst (WFA) software [45], which is a semi-empirical forest fire simulator, providing quicker operational results. WFA provides additional results such as flame length, flame intensity, rate of spread, out of suppression capacity and so on. WFA allows adjusting the rate-of-spread of the fire with the help of users' inputs of the location of the fire front.
- **Klimatilpasning** [48]: A *Climate Adaptation* portal with information about climate change and climate adaptation within a number of themes, and interactive tools provided by the Danish Environmental Protection Agency. It has been implemented in cross-border collaboration with ministries, regional authorities and research institutions and is made accessible to citizens, municipalities and businesses. It provides flood maps providing the user with an overview of vulnerable areas in the event of storm surge, rising water levels in streams and prolonged rain.
- **Ellegi Srl/LiSALab** [49]: Ellegi Srl provides commercial systems and services relating to monitoring with interferometric radar with a platform positioned on the ground of natural hazards, deformations of large structures. Their main activities include supply of products and services for environmental monitoring in the event of natural hazards, particularly landslides, observation of morphological changes to land, monitoring and diagnostics of buildings and other structures. The GBInSAR LiSALab system uses an interferometric sensor based on the Synthetic Aperture Radar (SAR) technique, similar to those used on satellites, but implemented in a mobile system with a terrestrial platform. Data acquisition, processing and analysis of the collected data is done with software packages developed by Ellegi Srl. It is similar to a product developed by CTTC and is based on research carried out at the European Commission's Research Centre in Ispra, Italy.
- **DIAN srl** [50]: Differential Interferometric Analysis, based in Italy, is a provider of remote sensing and non-destructive infrastructure monitoring engineering services. The services offered are based on SAR technology with data acquired by satellites and ground-based radar sensors. Their activities are centred on the areas such as landslides, landslips, morphological changes to land, static, dynamic and non-destructive monitoring of buildings and similar.
- **CAPRA** [51]: *Comprehensive Approach to Probabilistic Risk Assessment (CAPRA)* is an open-source model developed by the ERN-AL [30] consortium for the World Bank, the Inter-American Development Bank and the UN-ISDR for different activities of disaster risk management including risk financing. The software is comprised of modules of hazards, vulnerability and risk, and allows determining conjoint or cascading hazards. It includes hazard mapping, risk evaluation, and tools for cost-benefit analysis that support proactive risk management.
- **OpenQuake** [51]: A free open-source platform provided by the Global Earthquake Model foundation for assessment of earthquake hazard and risk. This provides impact and risk assessment tools similar to the development carried out by CIMA for HEIMDALL.

3.2.3 Research – past and ongoing

Effort within this section is to consolidate an overview of the research in recent years, funded either under EU funding schemes and/ or national funding sources. These projects have assisted several small and medium enterprises in bringing innovative disaster management tools and technologies to the market. These research programmes have helped to build a network and cooperation framework between research institutes and industry, both pan-European and outside Europe. In addition, these initiatives have provided improvement along various facets such as:

- Improved understanding, knowledge sharing and capacity building
- Improved skills utilisation, transferability and cross-border cooperation
- Improved technologies for early detection and monitoring

- **I-REACT** [53]: *Improving Resilience to Emergencies through Advanced Cyber Technologies* (I-REACT) is an EC/H2020 funded project that finished in May'19. It has developed the first European-wide platform to integrate emergency management data coming from multiple sources -satellites, social media, and incoming reports from responders using the I-REACT app, weather forecasts – to provide solutions that offer an improved assessment, planning and response to a disaster. The proposed system targets public administration authorities, private companies, as well as citizens in order to provide increased resilience to natural disasters through better analysis and anticipation, effective and fast emergency response, increased awareness and citizen engagement. *I-REACT* integrates multiple systems and European assets, including the Copernicus EMS, EFAS, EFFIS, and European Global Navigation Satellite Systems (E-GNSS), e.g. Galileo and EGNOS. Solutions are provided as three core services and eight value-added services. In addition, selected components of the system are being provided as an OpenAccess system. The app from the project is available in iOS and Android versions.
- **A4EU** [54]: *ANYWHERE For Europe (A4EU)* is a prototype multi-hazard platform developed as part of an ongoing H2020 project *ANYWHERE*. It aims to establish a pan-European platform in extreme climate risks that will enable to identify in a number of geographic regions, critical situations that could lead to loss of life and economic damages. The platform will, therefore, serve as a decision-making tool for various authorities when faced with a crisis and will provide state-of-the-art early warning systems to help exposed populations avert disaster. It has seven operational platforms in seven pilot sites across Europe, one of which is being trialled by the Civil Protection of Catalonia to request flood extent images from TerraSAR –X and VHR optical satellite. In comparison to *ANYWHERE,* HEIMDALL focuses on emergency management, providing a local-scale solution, more relevant for preparedness and response phases.
- **DRIVER+** [55]**:** *Driving Innovation in Crisis Management for European Resilience* is an ongoing EC/FP7 project that aims to augment the existing crisis management capabilities within Europe. The main objectives of the project are developing a pan-European testbed for crisis management capability development, testing and evaluation for stakeholders and practitioners, a database-driven website to document all the solutions, and a framework to facilitate a shared understanding of Crisis Management across Europe. Products developed in this project has close synergy with HEIMDALL and is one of the projects that the HEIMDALL consortium is closely aligned with to promote standardisation and dissemination of our work.

- **IN-PREP** [56]**:** *An integrated next-generation preparedness programme for improving effective inter-organisational response capacity in complex environments of disasters and causes of crises,* is an ongoing EC/H2020 project that aims to address the lack of training capabilities and insufficient links in transboundary crises management by improved collaborative response planning. Along with an open-source handbook on transboundary preparedness, an IT-based training platform: MRPP (Mixed Reality Preparedness Platform), for inter-agency training is being developed and tested as part of this project.
- **VESTEC** [57]**:** *Visual Exploration and Sampling Toolkit for Extreme Computing* is an ongoing EC/H2020 project that aims to develop and evaluate methods and interfaces to integrate high-performance data analytics processes into running simulations and real-time data environments. Technosylva is collaborating with *VESTEC* on real-time data assimilation of field data for adjusting simulations in near-real-time and use of HPC (high-performance computing) to perform highly reliable simulations through the great reduction of uncertainty.

- **FIRE-IN** [59]**:** *Fire and Rescue Innovation Network* is an ongoing EC/H2020 project that has been designed to improve the national and European Fire & Rescue capability development

process and thus raise the security level of EU citizens. Its main objectives include identification and harmonisation of operational capability gaps, identification of solutions to address those gaps, the definition of fire and rescue strategic research and standardisation agenda (SRSA), and the development of a concept for more efficient use of test, demonstration and training facilities to support innovation and skills development.

- **Firefficient/ Lessons on Fire** [58]: *Lessons on fire* is a platform that allows generating debates, sharing quality information, finding documents, experts, and/or asking a professional opinion about the integration of forest fires risk in the European landscape learnt from other organisations. This was developed within the framework of EC funded *Firefficient* (Operational tools for improving efficiency in wildfire risk reduction in EU landscapes) project.

- **PREFER** [61]: set up a space-based end-to-end information service, based on satellite remote sensing data, to support prevention/preparedness and recovery phases of the Forest Fires emergency cycle in the European Mediterranean Region.

- **AF3** [60]**:** *Advanced Forest Fire Fighting,* an EC/FP7 project, integrated a variety of new technologies such as drone imagery to help fight a fire outbreak.

- **eFIRECOM** [62]: *Efficient fire risk communication for resilient societies*, a project co-funded by ECHO-Humanitarian Aid and Civil Protection, contributed to improving the interaction between local and national authorities and promote the use of decision support systems, risk-knowledge-exchange platforms, and awareness-communication tools.

- **ArcFUEL** [63]: Funded under EU's LIFE+ program, it delivers a complete, up-to-date methodology for fuel classification mapping for the Mediterranean region, harnessing remote sensing and earth-observation techniques.

- **FIREPARADOX** [64]: Provides a 2D fire propagation model and virtual reality forest area that can be used to train personnel about wildfire behaviour and firefighting training. It examines four components of fire – prescribed burning, Wildfire Outbreak, Wildfire Spread, Backfire suppression.

With a sharp increase in the number and scale of forest fires in the past 20 years, associated with socioeconomic changes, climate changes, and fire management policies, research efforts in Europe on the topic of forest fires has concentrated on 3 main areas: fire risk, fire behaviour and its effects, and fire suppression methods [39].

- **PREDICATE** [65]: Funded by EC/ECHO, *Preventing Disasters by Capitalising on Unmanned Aerial Systems Technology* project demonstrated the use of standalone UAVs for watch-keeping and patrolling regions of interest in order to enhance disaster prevention capabilities of civil protection authorities. Building upon this work, another project *SWIFTERS* [48] is being carried out which aims to deliver an open-source licensed software package featuring emergency operation planning capabilities enabled by UAV swarms such as task allocation to individual UAVs of the swarm.

- **SafeLand** [66]: An EC/FP7 funded project, the project aimed to provide EU member states with a means to help the decision-making processes connected to the prevention and management of landslides by identifying, according to the expected climate change, the European areas with major risks.

- **GALAHAD** [67]: An EU/FP6 project, aimed at developing new solutions for ground-based remote monitoring of landslides, avalanches, and glaciers related hazards. Its objective was to retrieve, using the developed technologies, field parameters that can be used in prediction algorithms for the early warning in emergency management, the long-term forecasting and the pre-disaster planning, in order to mitigate the natural risk effects.

- **FLOODIS** [68]**:** An EC/FP7 project that concluded in 2015, *FLOODIS* contributed towards combining Earth Observation and GNSS (GPS, Galileo, EGNOS/EDAS) technologies to deliver alerts and interactive maps on flooding risk/events to users in the geographical area at risk, leveraging on existing mobile communication assets for emergency response teams and affected citizens. A mobile application was developed as part of this project that allows information gathered on the ground by the assessment teams to be received and visualised at control centres. The project was implemented in partnership with UNESCO.

- **RASOR** [69]**:** *Rapid Analysis and Spatialisation of Risk,* is an EC/FP7 project that concluded in 2016 with an objective to develop a platform to perform a multi-hazard risk analysis to support full cycle of disaster management. 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. RASOR uses a scenario-driven query system to allow users to simulate future scenarios based on existing and assumed conditions, to compare with historical scenarios, and to model multi-hazard risk both before and during an event. RASOR is an open platform, with open data and models, useful to enable communities to perform multi-risk analysis. Post-project, users and practitioners such as UNOSAT and EC's Joint Research Centre have set up a 'Community of Practice'.

- **FLOOD-serv** [70]**:** *Public Flood Emergency and Awareness Service,* is a recently concluded EC/H2020 project with the objective to develop and provide a pro-active and personalized citizen-centric public service application that enhances the involvement of the citizen and will harness the collaborative power of ICT networks (networks of people, of knowledge, of sensors) to raise awareness on flood risks and to enable collective risk mitigation solutions and response actions. As part of the results, a portal has been made available to citizens of pilot and partner cities to contribute to flood risk mitigation.

- **CiProVoT** [71]**:** Co-funded by EU/Erasmus+ Programme, the *Civil Protection Volunteers Training* project aims to develop a trans-national training course module for civil protection volunteers. The project has stemmed from the fact that the development of disaster prevention and awareness in the Civil Protection is closely linked to the ability of the key stakeholders and the public on risk-management, disaster prevention and preparedness. The project provides open-access to educational resources and training sessions to civil protection volunteers and professionals.

- **SAYSO** [72]: *Standardisation of Situational Awareness Systems to Strengthen Operations in Civil Protection* is a recently concluded EC/H2020 project with a mission to develop an innovative European cost-effective Multi-Stakeholders Situational Awareness System (MSSAS), which will provide practitioners with user-friendly solutions, providing a clear picture of the situation at hand with relevant advice. Further development of the prototype system has been decided to be carried out as part of the European Fire Association.

- **Broadway** [73]: A follow-on of the *BroadMap* project [74], *BroadWay* is an ongoing EC/H2020 project aims to implement a pre-commercial procurement to develop a pan-European system that will enable a pan-European interoperable broadband mobile system for Public Safety and Disaster relief organisations (PPDR) enhancing service to citizens and interoperability across borders.

- **E2mC** [75]**:** *Evolution of Emergency Copernicus Services* is a recently concluded EC/H2020 project with a goal to demonstrate the technical and operational feasibility of the integration of social media analysis and crowdsourced information within both the mapping and early warning components of the Copernicus EMS. The project has developed a prototype of a new EMS component – *Copernicus Witness*- that extend the current remote sensing data-based system with information collected from remote digital volunteers and local eyewitness reporters.

3.2.4 Conclusion

Increased threat to the natural environment due to direct and indirect human intervention is being felt globally and it is an acknowledged fact that better solutions to prepare and respond to hazards are urgently needed. Even though a number of initiatives and systems are currently available to assist the emergency response agencies, there are still gaps, such as in capabilities available to address multi-hazard situations, knowledge sharing, connectivity and training. Most of the commercial systems currently available or under-development are specifically for individual agencies and do not support cooperation among organisations. However, research programs have identified these gaps and are providing promising solutions to address these issues. Also, through the collective programs set up by governments and changes in their policies to facilitate better advertisement, cooperation and open access to tools and solutions, a slow but steady change are being felt among the end-user community.

3.3 Customers

3.3.1 Serviceable Addressable Market

The HEIMDALL system has the potential to be used anywhere globally. However, the primary focus for the system in Europe, including the UK. The serviceable addressable market is defined based on the geocode standard developed by the European Union, called NUTS (Nomenclature of Territorial Units for Statistics – *Nomenclature d'Unités Territoriales Statistiques*) [22], for referencing the administrative divisions of the member states (See **Annex A**: NUTS CLASSIFICATION). **Figure 6** shows a representation of this categorisation.

The NUTS classification is hierarchical. Subsequent to the classification at member state territorial units, further levels are classified as:

- NUTS 1: major socio-economic regions, e.g. the UK is divided into 12 regions with 3 main regions - England, Wales, and Scotland. This level has a total of 104 regions.
- NUTS 2: basic regions for the application of regional policies, e.g. counties in England. This level has a total of 281 regions.
- NUTS 3: small regions for specific diagnoses, e.g. districts in England. This level has a total of 1348 regions.

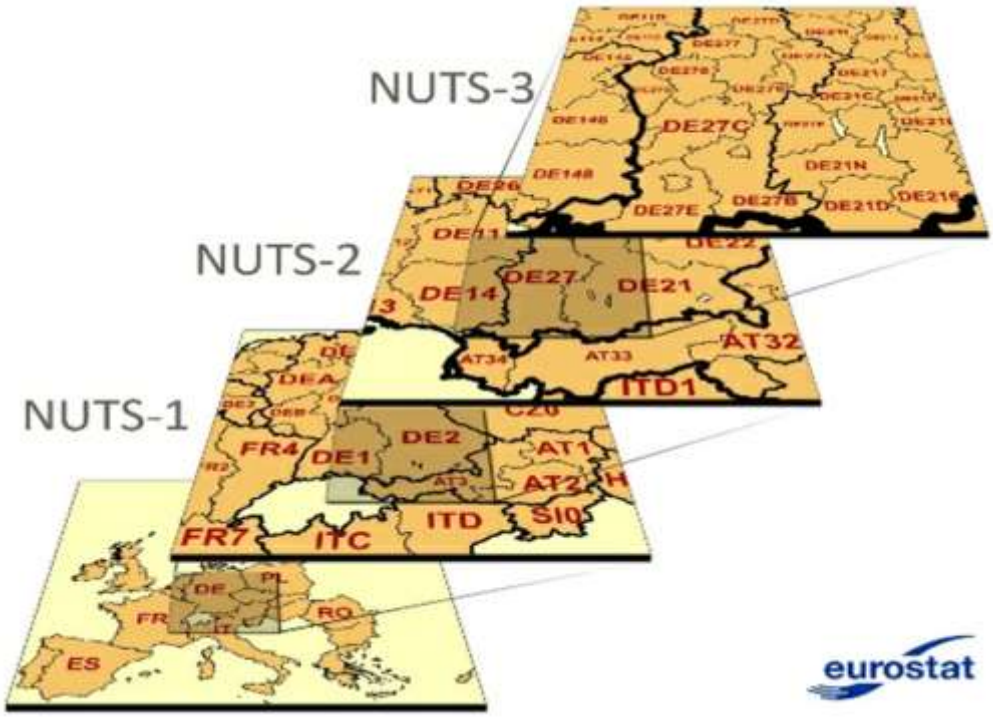

Figure 6: Representation of the Nomenclature of Territorial Units for Statistics [22]

Table 1 gives an example of NUTS classification for some other EU member states, based on recent data.

Table 1: Example of NUTS classification

Country	NUTS 1	NUTS 2	NUTS 3
Germany	16 states (*Länder*)	38 government regions (*Regierungsbezirke*)	401 districts (*Kreise*)
Spain	7 Groups of autonomous communities (*Agrupación de comunidades autónomas*)	19 autonomous communities and cities (*Comunidades y ciudades autónomas*)	59 Provinces + Islands + Ceuta and Melilla *(Provincias + islas + Ceuta y Melilla)*
France	*14 zones (Z.E.A.T-Zones d'études et d'aménagement du territoire)*	27 regions (*Régions)*	101 departments (*Départements*)
Italy	5 group of regions (*Gruppi di regioni*)	21 regions (*Regioni*)	107 provinces (*Province*)
Denmark	1	5 regions (*Regioner*)	11 provinces (*Landsdele*)

3.3.2 Early Adopters

Early adopters of the HEIMDALL system is envisaged to be the end-user partners - CFRS, SFRS, INT, CRI- of the consortium. As these partners have been involved with the development process of the system, they would be the best fit to take the platform through the exhaustive testing and validation of the pre-commercial phase. In addition, with their comprehensive understanding and experience of using the platform, they could provide credibility and help advertise the system among the end-user community.

From the discussions with the end-user partners, the feedback has been very positive. They, especially CFRS, have shown a great interest in the platform and have expressed their inclination to buy/ adopt the platform once it is at a more developed stage. As a commercial system, we presume that the main customers of the HEIMDALL system will be actors involved in disaster and crisis management at the national, NUTS 1, and/or at NUTS 2 level. For example:

- In Spain, the Military Emergency Unit acts at a national level, while the Civil Protection of Catalonia and the Catalan Fire and Rescue Service operate at the level of the autonomous community, Catalonia.
- In Germany the Federal Office of Civil Protection and Disaster Assistance controls:
    - the German Katastrophenschutz (disaster relief)
    - the Technisches Hilfswerk (Federal Agency for Technical Relief)
    - the Zivilschutz (civil protection) programs coordinated by the Federal Office of Civil Protection and Disaster Assistance. Local fire department units, the German Armed Forces (Bundeswehr), the German Federal Police and the 16 state police forces (Länderpolizei) are also deployed during disaster relief operations.

Private organizations could also be potential clients. For example, in Germany, some relevant companies that deal with emergency relief are the German Red Cross, Johanniter-Unfall-Hilfe (the German equivalent of the St. John Ambulance), the Malteser-Hilfsdienst, and the Arbeiter-Samariter-Bund.

4 Solution

In this section, the products are services that will be provided by a commercial HEIMDALL platform is explained. As the platform is modular, it allows offering tailored services that will suit the specific needs of the customers i.e. emergency service providers and first responders.

4.1 HEIMDALL Value Chain

The HEIMDALL platform comprises of various modules that are either stand-alone, dependent on other modules and/or external data sources. For a complete architecture description, please see [78]. **Figure 7** illustrates the value chain of the platform – the activities and entities involved in collating inputs from various data sources and providing the services requested by customers.

	Data provider	Data processor	Application provider	Communication provider	End User
Description	An organisation providing the data sets for the HEIMDALL platform to generate the products to support the DRM phases	Organisations providing tools to estimate the extent and potential behaviour of the hazards and generate useful information for the user – regional and cross-border	An organisation that integrates the various modules and provides the interface for the users to interact with the platform	An organisation providing a means to establish a communication channel between the control centre and the personnel on the field and for providing alerting services	Customers of HEIMDALL platform ○ PCF ○ CFRS ○ CRI ○ SFRS ○ FBBR ……..
HEIMDALL Products/ Services	○ Earth Observation data ○ Landslide Monitor data ○ Exposure Data ○ Aerial based data ○ Weather services ○ Other external services	○ Simulators – Forest fire, Flood, Landslide ○ Scenario Management ○ Impact Summary and Situation Assessment ○ Decision Support ○ Catalogue	○ Web-based GUI ○ Mobile App ○ Service Platform	○ Satellite Bandwidth ○ Satellite terminal ○ Wi-Fi terminal ○ Information Gateway	
Providers	○ SERTIT ○ DLR-DFD ○ DLR-KN-COS ○ CTTC ○ Third Parties	○ TSYL ○ ICGC ○ CTTC ○ CIMA ○ DLR-DFD/KN ○ SERTIT	○ AVA ○ SPH	○ AVA ○ DLR-KN	

Figure 7: HEIMDALL Value Chain

4.2 Service Packages

Figure 8 illustrates the interdependencies of the various modules/products of the platform and their services. HEIMDALL aims at designing and implementing an innovative multi-hazard open service platform which integrates space-based observation, satellite communications and navigation (Galileo/GNSS) assets to provide sustainable services for a wide variety of users in multi-application domains, such as prediction/early detection of emergencies, population alerting, environmental monitoring, crisis management and risk management.

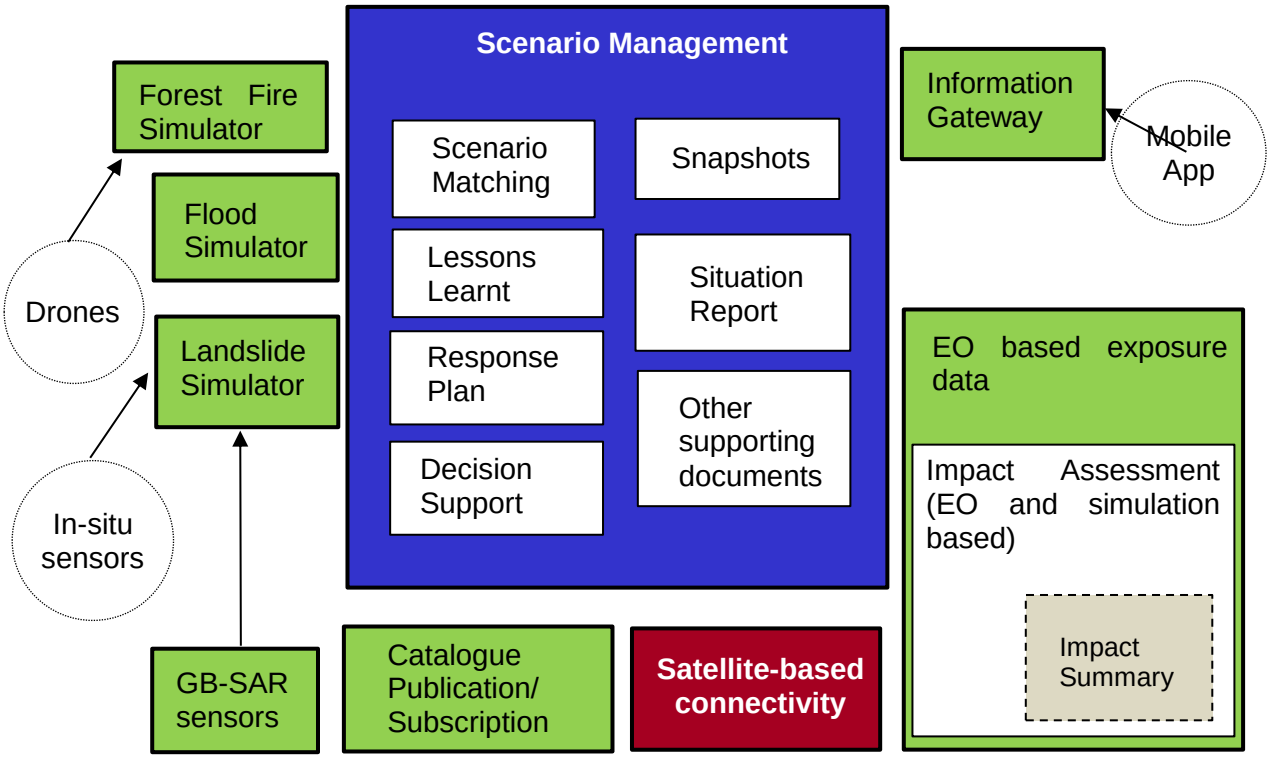

Figure 8: Schematic diagram showing interdependencies of HEIMDALL products and services

Services offered by HEIMDALL platform is scenario-centric i.e. optimum performance of the platform is when the various services offered by the modules are used in conjunction with the *Scenario Management* (blue box) product. In the schematic above, the services shown within the blue box indicate services that are completely dependent on scenario management and would not be coherent without a scenario. Elements in green boxes around the scenario management box represent products, and their related services, which can be used either as standalone or in conjunction with scenario management product.

To make use of the simulators, information about the local geography is needed which is usually available from national/ European environmental agencies. To use the Landslide simulator, information about the soil in the region of interest needs to be available in the database. GB-SAR sensor services can be used either to obtain just data, with or without scenario management, or in conjunction with the landslide simulator. To use in-situ sensors, sensor devices need to be installed locally by the interested local/national authority. Situation assessment reports, trend reports, real-time and remote monitoring, and alarms/ notification services are available as part of this module. For more details about the simulators, please refer [79].

Elements shown in circles are services that are best utilised if employed in conjunction with the products (green boxes) they are linked to. For example, drones subsystem developed within

HEIMDALL will detect hotspots and provide thermal images in wildfire situations. This information will augment the information available to firefighters and other emergency services providers responding to hazard event. Hence, drones will a best-fit if used in forest-fire hazard events along with forest fire simulator. For more details about the drones subsystem please refer [82].

Information Gateway (IG) module acts as the interconnect for communication between the web-based platform and the mobile application (APP) of HEIMDALL. It generates alerts, CAP messages that can be sent to users (only to end-users envisaged as part of the development within HEIMDALL). If used in combination with the Scenario Management product, the IG allows sending information such as situation reports and waypoints to the APP, gathering location information of the personnel on-field and exchanging pictures and instant messages. More details about these products can be found in [84].

HEIMDALL can provide *Impact Summary* for hazard events based on Impact assessment information. HEIMDALL can generate impact assessment information based on two different inputs - Earth observation (EO) data and simulation data [80]. For both these impact assessment datasets, it is essential to have exposure data for the region under consideration, produced from earth observation images. In HEIMDALL, Earth observation images are supplied by UNISTRA/ SERTIT [81]. As the HEIMDALL platform is dedicated to risk management including crisis management, a certain number of services are expected to be operational 24/7 or at least within a specific timeframe. Turn-around time and cost of these images depend on the satellite(s) used to obtain these images – commercial or free-to-use satellite services – and the urgency of the request. For EO based services, for requests made outside working hours, all the concerned technical partners will need to ensure they have the adequate on-duty capacity to meet the user requests. Hence ‘opening’ hours for these services need to be defined. Extended/ out-of-hours services will hence be priced higher than for normal service.

Catalogue module allows users to publish information and subscribe to information shared by other organisations. It can be used as a generic information sharing service if used as a standalone module. More details can be found in [84].

HEIMDALL also takes into consideration the requirement to provide an uninterrupted, easily deployable solution for connectivity in cases of emergencies. This can be easily met by employing satellite broadband connectivity. Using a VSAT equipped with Wi-Fi router, first responder users can easily connect to the internet to maintain their communication with the control centres and other users. In HEIMDALL, satellite connectivity is provided by Avanti over its HYLAS satellite fleet. To avail bandwidth, customers can choose to buy packages on a monthly or yearly basis. Bandwidth activation can also be done on an as-needed basis (2-3 days). However, it attracts a higher activation fee. More details about the broadband over satellite setup for HEIMDALL can be found in [83].

In addition, the web-based graphical user interface and the service platform are the two overarching imperative elements of the HEIMDALL platform. These are required to ensure seamless, efficient operation of the platform and its services. More technical details about these modules can be found in [85] [86].

4.3 Deployment Methods

Two service deployment formats are being considered to make the HEIMDALL services available to customers.

a) <u>Software hosted by the end-user</u>:

   HEIMDALL software can be provided to the customer as a set of files (executable files, resources…) that can be installed on the customer’s own servers. The main advantage of this format is that it enables the customers to keep control over the security of the system

and ensure the hosting of their own data. The software will be installed on the customer's server by the HEIMDALL service provider. The customer can also contact the service provider to procure and install the necessary hardware at their premises. To acquire and host the system by themselves, a larger initial investment is required from the customer. This solution is hence recommended for emergency services providers at a national level.

b) Software as a Service (SaaS)

SaaS is becoming more common and provides an economical solution when deploying and accessing software products that will otherwise be expensive to host and maintain by an individual organisation. In this deployment structure, HEIMDALL platform will be provided to end-user customers as software as a service on a subscription basis. To preserve the modularity of the platform and to ensure minimum overhead in terms of updates and technical support required for the modules, each module would be hosted by their respective technical partner organisation and brought together on the service platform or its equivalent by the service provider. This mode of deployment will relieve the responsibility of the customer of the management and maintenance of the platform, thus bringing the initial investment and operational cost down for customers.

From the response obtained from the consortium, this is the preferred solution for the technical partners. End-user partners are amenable to it given the modules and the platform as a whole can meet the necessary data security and privacy requirements detailed in **Section 6**.

4.4 Service Provider

After considering the different organisational types possible to offer the HEIMDALL services in the operational stage, see **Annex B**: Types of Legal Entities for details, the option of a Joint Venture Enterprise (JVE) is decided to be best. Forming a JVE would allow the existing resources and assets to be pooled and maintain the modularity of the platform in addition to joint proprietorship and adequate freedom for the module developers. Whether this JVE will be headed by one organisation or a combination is yet to be decided. The profits made by the exploitation of the HEIMDALL platform will be split between the partners of the JVE proportionally to the percentage of their contribution to capital and resources. In order to create the JVE, there will be a written agreement that will cover type of the business entity depending on the country it will be registered under. This will dictate the organisational structure under the local corporate law.

4.5 Benefits and Differentiators

This section attempts to answer the questions:

- What innovation sets HEIMDALL apart from the current systems/prototypes available in the DRM sector?
- What benefits does the system bring to the DRM sector?

Section 3.2 provided a high-level overview of the various systems and tools available commercially and as prototype in the disaster and risk management sector. Most of these systems provide products/services that are similar to that being developed within HEIMDALL. To understand categorically the benefits brought to the DRM sector by HEIMDALL and the factors that differentiate the platform from the IT systems known to the consortium and the wider end-user community, we circulated a questionnaire within the consortium and, through them, to their contacts.

Figure 9: Key Benefits of HEIMDALL from questionnaire responses

Figure 9 illustrates the key benefits consolidated from the responses received for the questionnaire. Compared to the other systems, HEIMDALL offers a modular, multi-hazard platform that has been developed in close interactions with the end-users and thus is a knowledge-based platform. As a modular system, HEIMDALL allows simplified scaling and allows tailored services for customers with minimal change at the back-end. Most of the reported systems are useful in the response phase of hazard events. However, the scenario-based design of HEIMDALL allows various details of a hazard event, e.g. evolution, forecast, simulations, and decisions by the agencies in the preparedness and response phases of an event to be associated together. HEIMDALL will assist first responders to move from reactive to deploy proactive responses, to be more efficient in emergency response planning, and to contribute to prevention: simulation of potential fires and their effect, simulate the effectiveness of prevention measures over the landscape, etc. It also features provisions to access information on historic events, creates fictitious scenarios, information sharing services allowing knowledge sharing and co-ordinated training experience within and between agencies. With the use of plug and play satellite terminal equipped with Wi-Fi, HEIMDALL prototype allows end-user organisations to benefit from the ubiquitous satellite broadband coverage provided via HYLAS fleet. Moreover, the mobile application permits real-time information sharing and asset tracking between the control centre and personnel on the field.

Additionally, spatial data created within HEIMDALL is INSPIRE [77] compliant, enabling data sharing between European public sector organisations.

Price for the systems mentioned earlier have been difficult to come by, as this information is often confidential. However, with the help of the partners, we were able to gather some information relating to, e.g. budget earmarked for emergency interventions (aircraft, fire-trucks, hire specific facilities and measures, food, beds, etc.). In addition, as the functionalities offered by these systems are quite varied, the cost figures do not allow a one-one comparison, but rather, acts as a reference. This information will be helpful while deciding the price for HEIMDALL services. From the information received,

- Catalonia spends around 15-20M€ each year only for the fire season. About 20% is for aerial firefighting.
- Spain's budget for the fire season is around 85-80M€, of which, it spends around 45-50M€ for aircraft. Less than 10% is dedicated to prevention, training actions, etc.
- Cost breakdown for one of US-based commercial system (web-based system and mobile app) that is being trialled by one of the end-user partners:
    - Development: 300,000 €
    - Server, hardware, software: 250,000 €
    - License: 50,000 €
    - Annual maintenance at 10%: 30,000 €
- For a bespoke command and control system being developed by Systel for SFRS is estimated to cost about €6m for the initial build. Training and ongoing support will be charged as additional operational cost.

5 Financial Analysis

This section provides details about the cost and effort involved in the future development and provision of the HEIMDALL platform as a commercial system.

5.1 Further development

HEIMDALL system is a prototype and at the end of the project in October 2020, most of the modules will be at TRL7, with some modules at TRL 8. **Table 2** gives a description of these technology readiness levels (TRL) as per the H2020 work programme [76]. From the responses obtained from the technical partners, **Table 3** shows the expected TRL levels of the modules by the end of the project.

Table 2: TRL description as per Horizon 2020 work programme 2014-15

Technology readiness level (TRL)	Description
TRL 1	basic principles observed
TRL 2	technology concept formulated
TRL 3	experimental proof of concept
TRL 4	technology validated in lab
TRL 5	technology validated in relevant environment (industrially relevant environment in the case of key enabling
TRL 6	technology demonstrated in a relevant environment (industrially relevant environment in the case of key enabling
TRL 7	system prototype demonstration in operational environment
TRL 8	system complete and qualified
TRL 9	actual system is proven in an operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Table 3: TRL of HEIMDALL modules by the end of the project

TRL 7		TRL 8
Drone sensors	Service Platform	Forest Fire simulator
Scenario Matching	Landslide Simulator	Web-GUI
Impact Summary Generation Service	Geotechnical/ hydrological in-situ sensors	Mobile App
SitRep Generation Service	Simulation-based Impact	EO based Impact
Decision Support Service	Flood Simulator	
Catalogue Service	In-situ sensors	
nformation Gateway	EO data products	

To make the system commercially available, the modules need further development and testing in an operational environment. Additionally, the modules and the system as a whole will need to have appropriate certifications and contracts in place to address matters of security, privacy and IP rights. From the responses gathered from the technical partners, time effort estimated for further development is consolidated in **Table 4**.

Table 4: Effort for further development

Module	Owner	Time effort estimate
Scenario Matching	DLR-DFD	6-12 months
Impact Summary Generation Service		6-12 months
Situation Report Generation Service		6-12 months
Decision Support Service		6-12 months
Drone system	DLR-KN-COS	12 months
Information Gateway	DLR-KN	6-12 months
Catalogue service		6-12 months
Earth observation data	UNISTRA/SERTIT	approx. 6 months
Earth observation-based impact assessment		The semi-automated system is at TRL 9; the fully-automated system is >TRL 8
Forest Fire simulator	TSYL	approx. 4 months
Flood Simulator	CIMA	6-12 months
Simulation-based impact assessment		6-12 months
GB-SAR in-situ sensors (software)	CTTC	approx. 10 months
Landslide simulator	ICGC	3-6 months;
Geotechnical/Hydrological in-situ sensors		Implemented on a per region per request basis. Currently information available only for Catalonia (Spain) and Monesi (Italy) regions.
Satellite Broadband	AVA	2-3 days; (activation time assuming partners have VSAT

		kit)
Web-based graphical user interface	AVA	Development of these components is largely dependent on the future development of the other modules.
Mobile application		
Service Platform (transition to cloud infrastructure, user and role management)	SPH	

For the in-situ sensors to monitor terrain movement, the cost to get to TRL9 has been estimated to be about €20,000. This would include hardware upgrade needed to move from TRL7 to TRL9 (with the increase in the number of queries that could be involved) and the time required to upgrade the software (introducing the local soil parameters of the region under interest into the code) to a production environment from its current prototype state. The cost involved in assessing local geotechnical parameters of soils, local geology and its geotechnical parameters, in a particular region is not included in the above estimate.

From the time-effort estimate, provision of a complete HEIMDALL system would require approximately 12 months in terms of module development and integration. Additionally, we also need to consider efforts required for the testing, validation exercises of the end-end system, and the certification processes mentioned previously. It is, hence, assumed that the system will require an additional 2 years of effort to be brought to a revenue-generating stage. During the development phase, the system can be offered as a pre-operational system for the end-users to trial. This will help the technical partners to obtain continued feedback in the development phase. This proposal is still under discussion. The final decision will be presented in D7.7.

5.2 System deployment cost

As explained in Solution4, it has been agreed within the consortium that to ensure the smooth running of the system, the best way will be for the modules of the HEIMDALL system to be developed and hosted by respective technical partners i.e. a decentralised deployment. Based on this assumption, in this section, a high-level view of the capital and operational costs (CapEx/ OpEx) involved for individual modules (or combined, if being provided by the same organisation) is presented.

5.2.1 CapEx

Table 5 provides an estimation of the cost to acquire the physical or non-consumable assets of the system. Main cost components have been identified as costs of the servers, software (firewall and antivirus) and the installation of the hardware and the software. These costs are for a year. In cases where deployment is on a cloud infrastructure hosted by a third party, installation costs are not applicable.

Table 5: HEIMDALL CapEx

Category	Component Details	Quantity	Unit Cost (€)	Total yearly cost (€)
Service Platform/ User & Role Management/ External Interfaces[1]				
Web Server to host the system	D4v2 Azure Compute Instance 4 Core CPU 16GB RAM 64GB HDD	3	345	12420
Storage Server	D2v3 Azure Compute Instance 2 Core CPU 8 GB RAM 512 GB HDD	2	160	3840
Firewall and Antivirus	Azure Application Gateway 50Mbps 500 GB/month	1	385	4620
Installation	Not applicable	-	-	-
Miscellaneous	1 Static IP 1TB Bandwidth per year	1	10	120
Forest Fire Simulator[1]				
Web Server to host the system + perform calculations	Azure F4s v2 4 Core CPU 8 GB RAM 1TB storage OS: Windows Server 2012 R2 Datacenter	1	4140	4140
Database Server	Azure D2s v3 2 Core CPU 8 GB RAM 256GB storage OS: Windows Server 2012 R2 Datacenter Database: SQL Server 2014 Web edition	1	2340	2340
Backup Server	Azure A1 2 Core CPU 2 GB RAM 1TB storage	1	1728	1728

[1] Assumes cloud deployment

Category	Component Details	Quantity	Unit Cost (€)	Total yearly cost (€)
	OS: Windows Server 2012 R2 Datacenter			
Firewall and Antivirus	Firewall: Network Security Groups Antivirus and Malware: Microsoft Endpoint Protection Intrusion Detection System: Security Center Standard Tier	3	180	540
Installation	Not applicable	-	-	-
Miscellaneous	Baremetal backups, Static IPs	3	660	1980
Flood Simulator				
Web Server to host the system (including Storage server)	Dell PowerEdge R6740 16 Core CPU 128 GB RAM 3TB storage	1	5000	5000
Firewall and antivirus	*<already available at CIMA premises>*	-	-	-
Installation		0.5PM	*TBC*	*TBC*
Miscellaneous (Switches, rack, router etc.)	*<to be finalised >*	*TBC*	*TBC*	*TBC*
Landslide Simulator[2]				
Application Wed server for the simulator and in-situ sensor module	Virtual Machine: 4 Core CPU 4GB RAM 70 GB storage OS: Ubuntu server 16.04.4 LTS	1	525	525
Support server to connect the service platform through the VPN	Virtual Machine: 2 Core CPU 4GB RAM 50 GB storage OS: Windows 7	1	475	475

[2] Includes continuous and dis-continuous monitoring; deployment is on a per region/per request basis

Category	Component Details	Quantity	Unit Cost (€)	Total yearly cost (€)
	Professional			
Firewall and Antivirus	Palo Alto peripheral firewall, Bitdefender Gravity Zone for VMware ESX, Radware Alteon Network Load Balancer and Application Delivery Centre	2	50	100
Sensors	Number and costs depends on the region	*TBC*	*TBC*	*TBC*
Installation	1 hour of a system administrator	2	50	100
Miscellaneous	1Gbps and 10 Gbps network switches and routers. Veam Backup. CPD cooling. UPS. PRTG Monitoring. Operation service and platform incident solutions	2	250	500
Drones (MAV swarm)				
Basestation	Tablet computer: DELL Latitude 7212 Rugged Extreme Tablet Long-range mesh communication system: MCU-30 ruggedized from Mobilicom Wi-Fi router	1	9000	9000
Drones	Drone platform - DroneX design according to DLR specifications Long-range mesh communication system: MCU-30 lite from Mobilicom Onboard computer: Intel i7 Core, 32GB RAM, 500GB SSD Visual camera: mvBlueFOX-MLC202bC from Matrix Vision with an 82 degrees angle of view lens Thermal camera: Optris PI 400 with a 29 × 22 degrees	4	20600	82400

Category	Component Details	Quantity	Unit Cost (€)	Total yearly cost (€)
	angle of view lens			
Scenario Matching/ Exposure data / Situation Assessment (Impact Summary, EDXL-SitRep adapter, Decision support)				
Web Server to host the system	Virtual Machine: 2 Core CPU 4GB RAM 1TB HDD OS: CentOS 7	3	800	2400
Firewall and Antivirus	*Required*	*TBC*	*TBC*	*TBC*
Installation	*<man hours>*	3	500 (min €300)	1500
Miscellaneous	Server, switch, UPS, rack, cables etc.	3	20000 (min. €10000)	60000
Earth Observation products				
Server + display (hosted at UNISTRA/SERTIT premises)	CPU: Intel 9 series Coffee Lake Memory: 64GB Storage: 1TB SSD + 8 TB (HDD RAID 1) GPU: GeForce 2080 RTX OS: Windows 10 64bit Display: Dual screens FHD IPS 27"	2	5000	10000
Firewall and Antivirus	*Required*	*TBC*	*TBC*	*TBC*
Server at DLR-DFD	Virtual Machine: 2 Core CPU 4GB RAM 1TB HDD OS: CentOS 7	1	800	800
Miscellaneous	Server, switch, UPS, rack, cables etc.	1	20000 (min. €10000)	20000
Catalogue Services				

Category	Component Details	Quantity	Unit Cost (€)	Total yearly cost (€)
Web Server	Virtual Machine: 4 Core CPU 6 GB RAM 1TB storage OS: Ubuntu	1	1200	1200
Backup server	*Required*	*TBC*	*TBC*	*TBC*
Firewall and Antivirus	*Required*	*TBC*	*TBC*	*TBC*
Installation	16 hours	*TBC*	*TBC*	*TBC*
Miscellaneous (Switches, rack, router etc)	*Required*	*TBC*	*TBC*	*TBC*
Information Gateway				
Web Server	Virtual Machine: 4 Core CPU 6 GB RAM 1TB storage OS: Ubuntu	1	1200	1200
Backup server	*Required*	*TBC*	*TBC*	*TBC*
Firewall and Antivirus	*Required*	*TBC*	*TBC*	*TBC*
Installation	16 hours	*TBC*	*TBC*	*TBC*
Miscellaneous (Switches, rack, router etc)	*Required*	*TBC*	*TBC*	*TBC*
Web Interface				
Web Server	Virtual Machine: 4 Core CPU 6GB RAM 1TB HDD	1	900	900
Firewall and Antivirus		1	300	300
Display		3	250	750
Installation	Not applicable	-	-	-
Mobile Application				
Cost of hosting the application		1	150	150

A few details in the table above is yet to be clarified and a complete list will be included as part of the cost-benefit analysis in the second issue of this deliverable, D7.7.

5.2.2 OpEx

Elements that contribute to the operational (recurring) costs for the HEIMDALL system have been identified as costs for software maintenance, internet connection, hardware and software upgrade, and support. A high-level estimate of the costs has been put together in **Table 6.** As the definition of interactions between certain modules and their development is still being discussed at the time of this report and finer granularity on the service offering of these modules is still to be finalised, operational cost estimation for all the modules is not available at the time of this report. However, these open points have been raised at the progress meeting in October'19 and are expected to be clarified by the final demonstration in Mar'20.

Table 6: OpEx of HEIMDALL modules

Category	Details	Quantity	Unit cost (€)	Total yearly cost (€)
Forest Fire Simulator				
Software maintenance	Yearly maintenance fee and ongoing support per unit/licence	1	2000	2000
High Speed Internet Connection	Yearly cost	1	720	720
Licensing	3x Windows Server 2012 R2 Datacenter Edition 1x SQL Server 2014 Web Edition	*Included in the Azure server costs*	-	-
Additional hardware/upgrade (to support added customer base in 5 years)		--	-	5000
Personnel cost	*TBD*	*TBD*	*TBD*	*TBD*
Scenario Matching, Exposure, Situation Assessment (Impact Summary, EDXL-SitRep adapter, Decision support)				
Software Maintenance	Yearly cost			10000
Ongoing Support	Yearly cost			10000
High-Speed Internet Connection	Yearly cost			1000
Licensing	Yearly cost			50000

Category	Details	Quantity	Unit cost (€)	Total yearly cost (€)
Support Personnel	Yearly cost			80000
Additional hardware/upgrade (to support added customer base in 5 years)				40000
Flood Simulator				
Software maintenance	Personnel	1* 3 months	6000	18000
Ongoing Support	Personnel	1* 3 months	5500	16500
Landslide Simulator				
1Gbps and 10 Gbps network switches and routers. Veam Backup. CPD cooling. UPS. PRTG Monitoring. Operation service and platform incident solutions		2	250	500
Earth Observation Products				
Licensing ArcGIS PCI Geomatica	*Already acquired*		-	
Support Personnel IT +EO engineer		2	-	
Additional hardware/upgrade (to support added customer base in 5 years) Ready to use desktop		2	5000	10000
Satellite Bandwidth				
TBD				
Web-GUI				
TBD				
Mobile application				
TBD				

Category	Details	Quantity	Unit cost (€)	Total yearly cost (€)
Service Platform/ User & Role Management/ External Interfaces				
High speed internet	1 Static IP 1TB Bandwidth per year			120
Server rental and maintenance				20880
Drones (MAV Swarm)				
TBD				
Catalogue Services				
TBD				
Information Gateway				
TBD				

5.2.3 Cost-Benefit Analysis

A detailed analysis of funding required to further develop the system and to run a sustainable enterprise in the operational stage will be provided in the second issue of this deliverable, D7.7.

6 Commercialisation and Exploitation Plan

This section looks into questions relating to the sustainability of HEIMDALL system such as:

- How will the system be made available after the end of the project - service provider and structure of the consortium after Oct 2020?
- What is the plan to make sure the prototype survives the 'valley of death'?
- What legal and standardisation requirements need to be met?
- What is the plan to generate revenue?

6.1 Post-project: Short Term

The responses received from the discussions with the technical and end-user partners of the HEIMDALL consortium about their standpoint about the further development and qualification of the prototype to take it to a fully tested and validated operational (TRL 9) system have been encouraging. In recent discussions, the end-users have expressed their satisfaction with the progress of the platform and consider the possibility of using the services of the operational system for their organisational needs.

Often innovation projects meet a dead end due to lack of funding beyond the prototype development stage. This phase between prototype and successful market introduction, which comes with a high technological and financial risk, is commonly known as the 'Valley of Death'. Research organisations and, in a large number of cases, SMEs depend on government funding to develop and market innovative solutions. With a multi-disciplinary solution like HEIMDALL, the investment required developing the prototype, test and validating to reach high TRLs, and market the system is beyond the financial provisions and expertise available to these organisations to attempt in isolation. In addition, in the recent years, there is a global shift in the approach of government agencies on how the results from the work funded by them are disseminated and shared so that everyone – industry and citizens- have access to that knowledge and are able to use innovation workflows to analyse, publish and commercialise these findings [87].

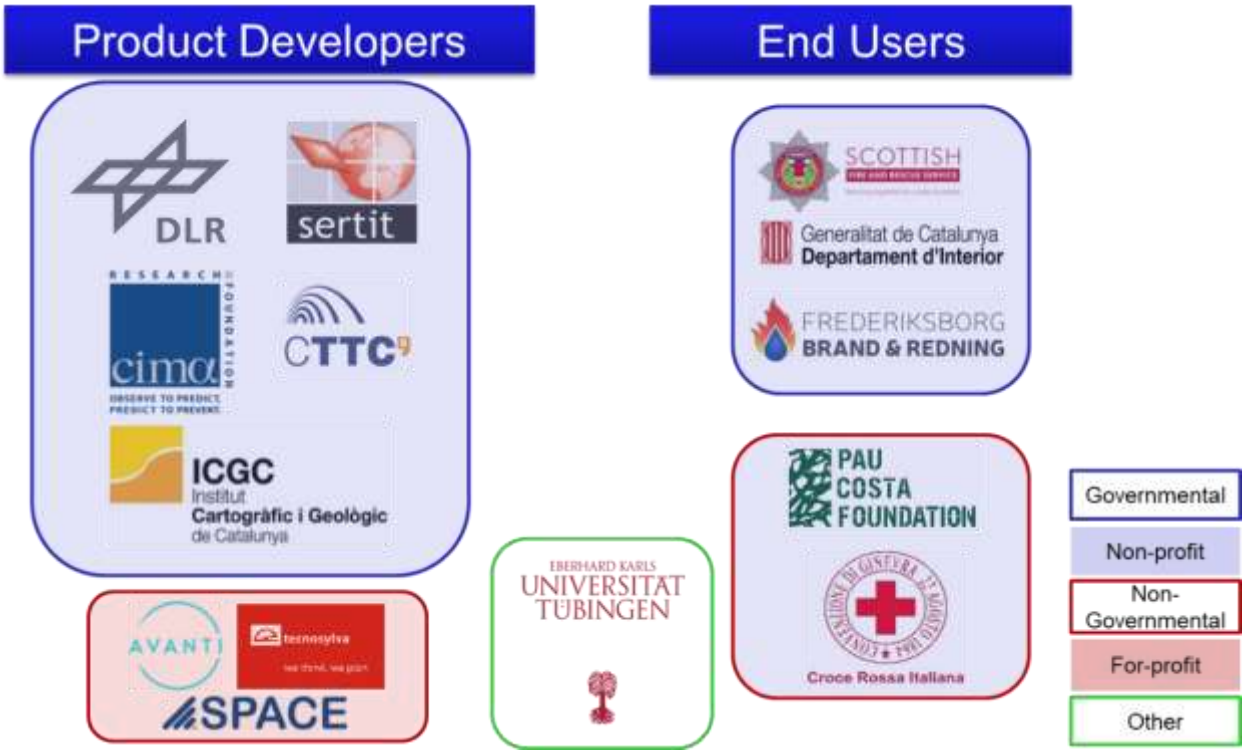

Figure 10: Legal disposition of HEIMDALL consortium

Section 5.1 provides an estimation of the effort in terms of time foreseen by the technical partners to address the user requirements and to provide the additional functionalities they have planned for their module(s). Except for Space Hellas (SPH), Avanti (AVA) and Technosylva (TSYL), the other technical partners of the consortium are governmental, non-profit organisations i.e. they are partly or fully owned by government institutions and rely on the financial support from these bodies to operate. In addition, their revenue generation is solely for the day-day running of the organisation and are not obliged to earn profit for its owners. This legal disposition (**Figure 10**) of the technical partners plays a pivotal role in the financial options open to the consortium in the post-project development stage and in the commercialisation stage later on. From the discussions with the partners, the most viable solution to ensure continued sustainable development of the modules and the platform as a whole post-project is via a short-term (18-24 months) public grant funding, preferably from the European Commission. Similar to the non-commercial technical partners, the majority of the end-user partners in the present consortium are local-government funded and would require additional financial support to offer the efforts to test and validate the system post-project. For the commercial partners to procure the IPR to further develop the platform, their initial investment is estimated to be excessively high and more importantly, the concept of the HEIMDALL system doesn't align fully with these organisations' objectives.

Additionally, to comply with the new shift in policies of the EC and other global government bodies towards open access to research outcomes, the partners and end-users have expressed their willingness to provide access to the research outputs of the project, wherever possible, via OpenAIRE [88]. Some difficulties are foreseen in providing open access to the development work done by the commercial entities of the project however; this is not anticipated to hinder the progress of the other modules/products. One probable solution to this issue is for the non-commercial entities to procure IP rights for these works.

6.2 Post-project: Long Term

When moving onto the operational phase, there is certain regional and national level legal framework that the technical partners and end-users will need to adhere to. This section consolidates the responses we have gathered in relation to the policies and guidelines the partners will need to consider with respect to buying and/or selling the products and services that an operational HEIMDALL system would offer.

As a commercial service, data sharing and access will be in accordance with EU regulations, ensured by the service provider.

6.2.1 End-User Organisations

For the end-user organisations, information about personnel and assets is highly confidential and it is imperative that the systems/tools they employ fully comply with regulations around confidentiality of information, privacy and data security.

From the responses received from end-user partners, in the case that the operational HEIMDALL platform is provided by a private enterprise (a privately owned joint venture company), it will have to comply with GDPR (General Data Protection Regulation) under EU law. These organisations would also need assurance on secure transfer, storage and processing of data being shared via HEIMDALL platform. Data security measures are already in place as this applies to the project phase as well. An explicit confidentiality agreement, with a clear description of the roles of each partner, workflows and payment schemes, would need to be set in place in the operational stage between the product developers and end-users.

Keeping in line with the data privacy and the level of confidentiality required by the end-user organisations, they prefer installing the system on dedicated servers. However, owing to the

modularity of the system and to ensure up-to-date and reliable functioning of the platform, various modules of HEIMDALL require periodically updated information to be fed to the system, which in turn, require assistance from the product developers i.e. technical partners.

In terms of cross-border procedures and inter-organisation coordination, each end-user organisation is governed by its institutional, regional and national regulations. To that end, this topic needs to be considered on a case-by-case basis closer to the actual implementation of the system. However, to provide a flavour of the various regulations and complexity of the process, information gathered from partner organisation on the current procedure and processes they follow are presented below.

- In the UK, for inter-organisation coordination and cross-border operations, currently, a standard approach called JESIP (Joint Emergency Services Interoperability Principles) [89] is used. JESIP sets out a standard approach to multi-agency working, along with training and awareness products for responding agencies to train their staff. Along with the Civil Contingencies Act, JOSIC (Joint on Scene Incident Command) and IEM (Integrated Emergency Management) (valid for Scotland only)[3] are applicable as well.

- For the Italian Red Cross (CRI) any interagency coordination is managed at the FCP (Forward Command Post) level and cross-border procedures are agreed at the prefecture-level. In terms of data sharing, CRI is bound by internal regulations.[4]

- In Denmark, cross-boundary activities are co-ordinated by the Danish Emergency Management Agent (DEMA)[5].

- For the CFRS, cross-border incidents are handled in coordination with the Spanish Civil Protection agency. Co-ordination with the Catalan Civil Protection agency is via the Operational Coordination Centre of Catalonia (CECAT)[6].

6.2.2 Technical Partner Organisations

In the cross-border and inter-organisational operation scenario, the main topic that needs to be addressed from the technical partners' perspective is about IPR and knowledge management.

- For the EO products supplied by SERTIT, licencing and distribution of input data sources and output products need to comply with laws surrounding copyrights and licensing of data. The output products should follow the INSPIRE Directive [90]. ISO 9001 [91] quality management process is followed to ensure products are quality controlled.

- The forest fire simulator services provided by Tecnosylva is based on the capabilities and technology of their existing software product Wildfire Analyst® [92]. The only national and international limitations related to IPRs that may apply are the standard software copyright and the registered trademark, registered in Europe as well as in the United States of Wildfire Analyst®. No patent application has been made for the software developed for HEIMDALL and is not foreseen to do so at least in the midterm due to the high difficulty to get a patent approved for software, the related high costs and the long time the process takes (usually several years).

---

[3] Information provided by colleagues at the Scottish Fire & Rescue Services (SFRS).

[4] Information provided by colleagues at the Italian Red Cross (CRI)

[5] Information provided by colleagues at the Frederiksborg Brand og Redning (FBBR)

[6] Information provided by colleagues at the Catalan Fire & Rescue Services (CFRS)

- For German institutions, IPR and cross-border knowledge sharing are governed by the export regulations provided by the Federal office for Economic Affairs and Export Control (BAFA) [93]. For the drones system, guidelines from the EU on the use of drones will come into effect from July 2020 [94]. Similarly, IPR for UK based organisations is governed by laws set out by the Intellectual Property Office [95].

- Similar details for products developed by partners based in Italy and Spain are not available at this moment. These details will be included in the next issue of this deliverable, D7.7.

6.3 Standardisation and cooperation with existing projects

For HEIMDALL to be widely accepted and adopted, it is essential to ensure the platform complies with standards followed in the EU and has suitable maximum exposure and publicity. To this end, products developed in HEIMDALL have taken measures to ensure compliance with and/or participate in:

- OpenGeoSpatial (OGC) [96] and INSPIRE conformance

- Crisis Management Innovation Network Europe (CMINE) [97]: A community of practice in the field of crisis management. It is an umbrella network made to foster exchanges between diverse stakeholders who have a role to play in crisis management innovation in various domains such as wildfires, volunteer management and floods.

- Virtual Operation Support Teams (VOST) [98]: The VOST is a flexible, tested solution developed by a group of passionate emergency management communicators and technologists interested in harnessing information shared on social media during disasters, crises and critical events. It is a team of volunteers that help officials disseminate reliable information before, during, and after natural disasters to the local population. Discussions are ongoing to partner with VOST in Portugal to integrate data sourced from them which will entail additional support for emergency authorities to engage in real-time and informed.

- DRIVER+ consortium [55]: Collaborating with the team on standardisation of lessons learnt, test-bed solutions etc.

- LCMS [35]: It is a system being used by the Dutch National Crisis Management services. HEIMDALL is aiming to collaborate with the developers i.e. exchange of expertise on standardisation of exchanging operational pictures between different systems

7 Conclusion

With natural hazards becoming frequent and intense and causing increased damages to the population and economy, government bodies have recognised the need for systems that will foster efficient use of resources in disaster and crisis management. Comparing with other solutions available and/or being developed, HEIMDALL provides a unique comprehensive solution for the preparedness and response phases of the DRM cycle. In comparison with budget earmarked for emergency operations, the estimated cost to deploy a tailored HEIMDALL system is fractional. Also, with added benefits of standardised services, cross-border and inter-organisational operations can be carried out with ease.

Additionally, the consortium has reached a good understanding on further steps to progress the platform to an operational level. This needs to be further elaborated in relation to costs and prices for the services to have a sustainable enterprise. A detailed analysis performed in this regard will be presented in the next issue of this deliverable.

8 References

[1] HEIMDALL, D7.7: *Business Model Spreadsheet, Business Plan and Sustainability Report – Issue 2,* due M42.
[2] A. Maurya: Why Lean Canvas vs Business Model Canvas? blog.leanstack.com/why-lean-canvas-vs-business-model-canvasaf62c0f250f0
[3] A.Osterwalder: www.businessmodelalchemist.com/blog/2005/11/what-is-business-model.html
[4] www.worldbank.org/en/topic/disasterriskmanagement/overview
[5] www.openknowledge.worldbank.org/bitstream/handle/10986/25335/211003ovEN.pdf?sequence=3&isAllowed=y
[6] www.ec.europa.eu/echo/files/aid/countries/factsheets/thematic/disaster_risk_management_en.pdf
[7] https://www.eea.europa.eu/data-and-maps/daviz/natural-disasters-events-3#tab-chart_5_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22columnfilter_Filter%22%3A%5B%22Climatological%20event%22%3B%22Geophysical%20events%22%3B%22Hydrological%20event%22%3B%22Meteorological%20events%22%5D%7D%7D
[8] www.preventionweb.net/files/53884_swd2017176overviewofrisks2.pdf
[9] www.eu-policies.com/competences/climate/wildfires-europe-growing-risk
[10] www.effis.jrc.ec.europa.eu/media/cms_page_media/40/Annual_Report_2017_final_pdf_uCckgee.pdf
[11] www.ec.europa.eu/info/sites/info/files/181116_booklet-forest-fire-hd.pdf
[12] www.publications.europa.eu/en/publication-detail/-/publication/285d038fb543-11e7-837e-01aa75ed71a1/language-en
[13] Zbigniew W. Kundzewicz, Iwona Pińskwar & G. Robert Brakenridge (2012): Large floods in Europe, 1985– 2009, Hydrological Sciences Journal
[14] EU Solidarity Fund, Overview 2002-2016, http://ec.europa.eu/regional_policy/sources/thefunds/doc/applications_overview_en.pdf
[15] www.floodlist.com/europe
[16] www.ec.europa.eu/info/sites/info/files/com_report_wfd_fd_2019_en_1.pdf
[17] www.ec.europa.eu/info/sites/info/files/com_report_wfd_fd_2019_en_1.pdf
[18] www.gov.uk/government/news/uk-one-of-first-countries-in-europe-to-receive-google-flood-alerts
[19] www.google.org
[20] www.researchgate.net/figure/Preliminary-map-highlighting-areas-prone-to-landslides-in-Europe-based-on-the-so-called_fig12_275770482
[21] www.esdac.jrc.ec.europa.eu/themes/landslides
[22] Eurostat, Nomenclature of territorial units for statistics, available at: www.ec.europa.eu/eurostat/web/nuts
[23] Civil Protection Mechanism: www.ec.europa.eu/echo/what/civil-protection/mechanism
[24] Copernicus EMS: https://emergency.copernicus.eu
[25] EFFIS: www. effis.jrc.ec.europa.eu/
[26] EFAS: www.efas.eu
[27] rescEU: www.ec.europa.eu/echo/files/aid/countries/factsheets/thematic/resceu_en.pdf
[28] Climate-ADAPT: www.climate-adapt.eea.europa.eu
[29] GDACS: www.gdacs.org
[30] GFDRR: www.gfdrr.org
[31] ICL: www.icl.iplhq.org
[32] eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L1972&from=EN
[33] Systel: www.systel-sa.fr/en/company
[34] Assign: www.ordergroup.dk/om-os
[35] LCMS: www.lcms.nl/about-lcms
[36] MissionPlanner: www.ardupilot.org
[37] PIX4D: www.pix4d.com
[38] DEWETRA: www.mydewetra.org

[39] Cellnex: www.cellnextelecom.com
[40] ESRI ArcGIS: www.esri.com/en-us/arcgis/products/arcgis-online
[41] Collector App: www.esri.com/en-us/arcgis/products/collector-for-arcgis
[42] QGIS: www.qgis.org/en/site
[43] Information provided by HEIMDALL colleagues in CFRS and INT, Spain
[44] OruxMaps: www.oruxmaps.com/cs/es
[45] WildFire Analyst: www.pocket.wildfireanalyst.com
[46] PROPAGATOR: www.aqua.upc.es/anywhere-catalogue-v2/?product=propagator-propagation-of-a-wildfire-cima
[47] WIldFire Analyst: www.wildfireanalyst.com
[48] Klimatilpasning: www.klimatilpasning.dk/omportalen
[49] Ellegi srl: www.lisalab.com
[50] DIAN: www.dianalysis.eu
[51] CAPRA: www.ecapra.org;
[52] OpenQuake: www.globalquakemodel.org/openquake
[53] I-REACT: www.i-react.eu
[54] A4EU: www.anywhere-h2020.eu/services/multi-hazard-early-warning-platforms/a4eu
[55] DRIVER +: www.driver-project.eu
[56] IN-PREP: www.in-prep.eu
[57] VESTEC: www.vestec-project.eu
[58] Firefficient/Lessons on fire: www.lessonsonfire.eu
[59] FIRE-IN: www.fire-in.eu
[60] PREFER: www.prefer-copernicus.eu
[61] AF3: www.cordis.europa.eu/project/rcn/185483/factsheet
[62] eFIRECOM: www.ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/efficient-fire-risk_en
[63] ArcFUEL: www.epsilon.gr/projects/67
[64] FIREPARADOX: www.fireparadox.org
[65] PREDICATE: www.kios.ucy.ac.cy/predicate
[66] SafeLand: www.esdac.jrc.ec.europa.eu/projects/safeland
[67] GALAHAD: www.researchgate.net/publication/281458165_GALAHAD_an_EU_project_for_the_remote_monitoring_of_glaciers_avalanches_and_landslides
[68] FLOODIS: www.cordis.europa.eu/project/rcn/188848/factsheet/en
[69] RASOR: www.rasor-project.eu
[70] FLOOD-serv: www.floodserv-project.eu
[71] CiProVoT: www.ciprovot-project.eu
[72] SAYSO: www.sayso-project.eu
[73] BroadWay: www.broadway-info.eu
[74] BroadMap: www.broadmap.eu
[75] E2mC: www.e2mc-project.eu
[76] TRL definition H2020: www.ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf
[77] INSPIRE: www.inspire.ec.europa.eu
[78] J.M. Chaves et.al, HEIMDALL D2.12: *HEIMDALL System Architecture*, submitted Apr'18.
[79] M.Mendes, HEIMDALL D5.12: *Modelling and Simulation Services- Specifications –Draft,* submitted Mar'19.
[80] C.Knopp, D6.1: *Concept Design for Risk Analysis Methods and Components – Detailed Concept Design and Documentation of Methods on Risk Analysis- Draft*, submitted Nov'18
[81] S.Martinis, HEIMDALL D5.1: *EO Tools and Products- Specifications- Draft*, submitted Nov'18
[82] A.V.Ruiz, HEIMDALL D5.4: *Drone Sensors and In-Situ Sensors*, submitted Nov'18
[83] D.Mathew, HEIMDALL D4.16: *Communications to Remote Areas- Design and Specifications - Draft* , submitted Apr'19
[84] B.Barth, HEIMDALL D4.13: *Communications and Information Sharing- Specification*, submitted Apr'19

[85] A.Bartzas, HEIMDALL D4.1: *Service Platform Design and Specification-Draft*, submitted Nov'18
[86] D.Mathew, HEIMDALL D4.7: *User Interface Design- Draft,* submitted Nov'18
[87] Europe's Open Innovation: www.openaire.eu/open-science-europe-overview
[88] OpenAIRE: www.openaire.eu
[89] JESIP: www.jesip.org.uk
[90] INSPIRE: www.inspire.ec.europa.eu/inspire-directive/2
[91] ISO 9001: www.iso.org/iso-9001-quality-management.html
[92] Wildfire Analyst: www.wildfireanalyst.com/integration
[93] BAFA: www.bafa.de/EN/Home/home_node.html
[94] Drones EU regulation: www.easa.europa.eu/newsroom-and-events/press-releases/eu-wide-rules-drones-published
[95] UK IPO: www.gov.uk/government/organisations/intellectual-property-office
[96] OGC: www.opengeospatial.org
[97] CMINE: www.cmine.eu
[98] VOST: www.epicentermediatraining.com/vost/

9 Annex A: NUTS CLASSIFICATION

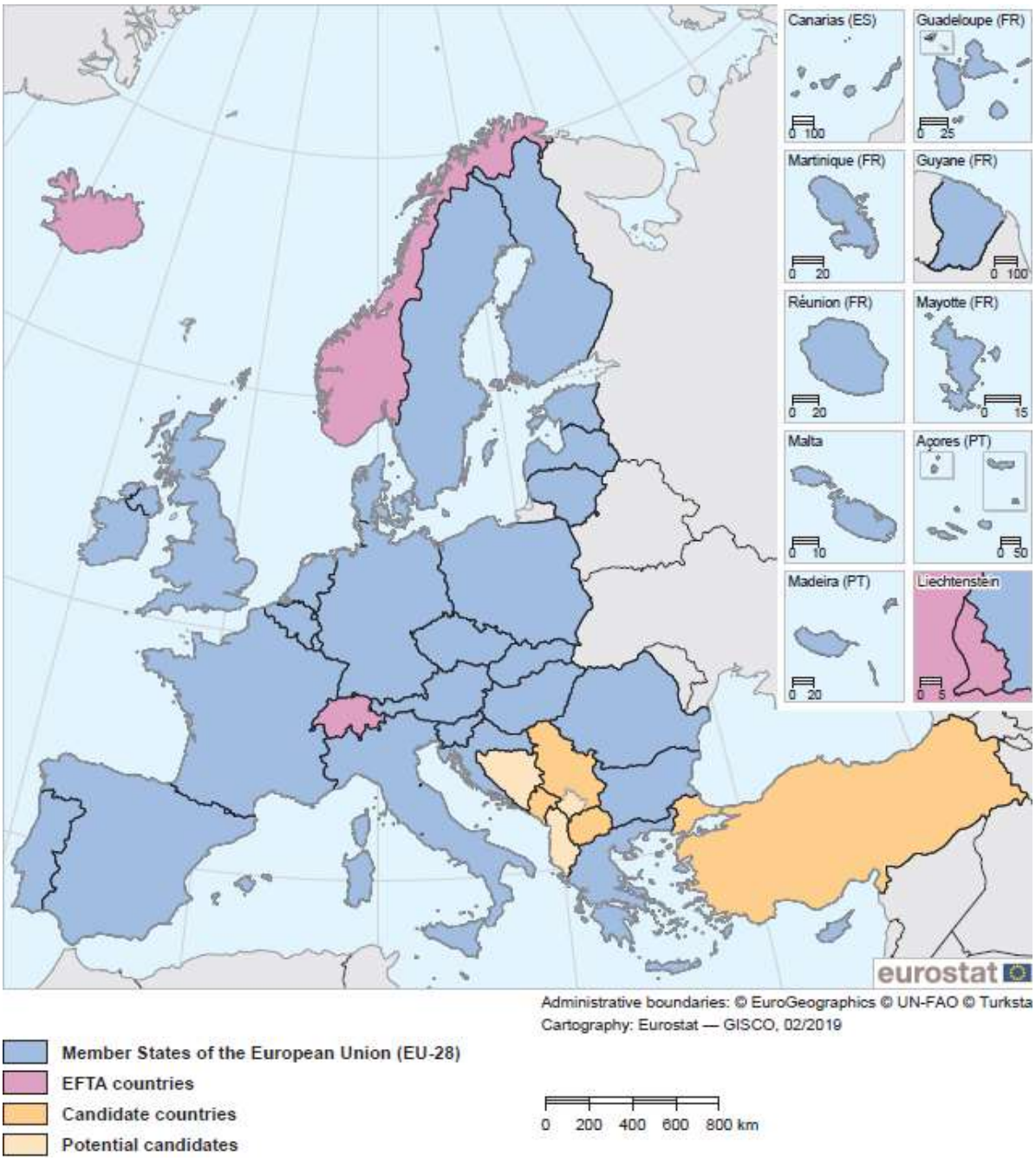

Figure 11: Countries in the Member States of the European Union (EU-28; in blue) according to NUTS 2016.

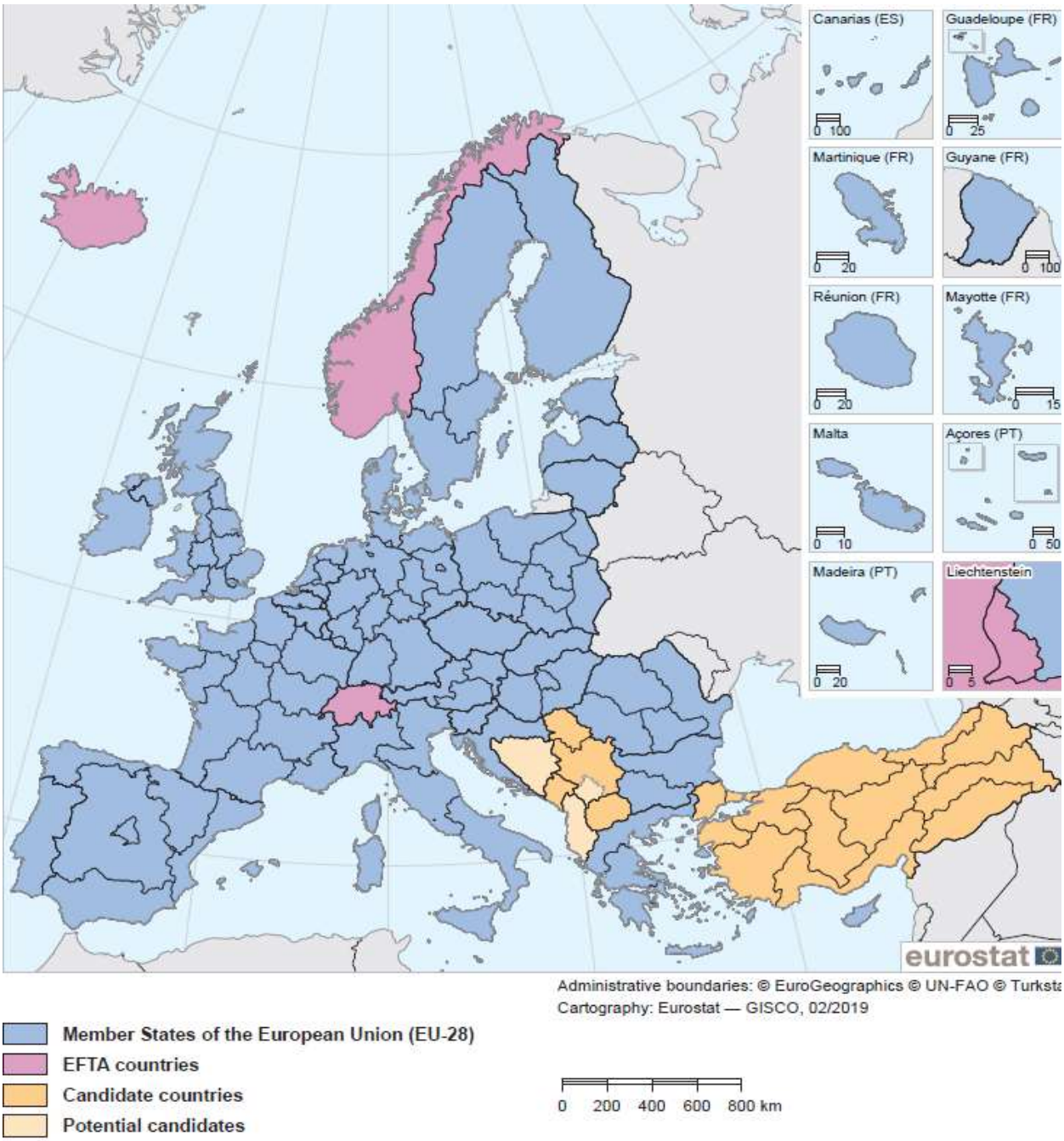

Figure 12: NUTS 1 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016

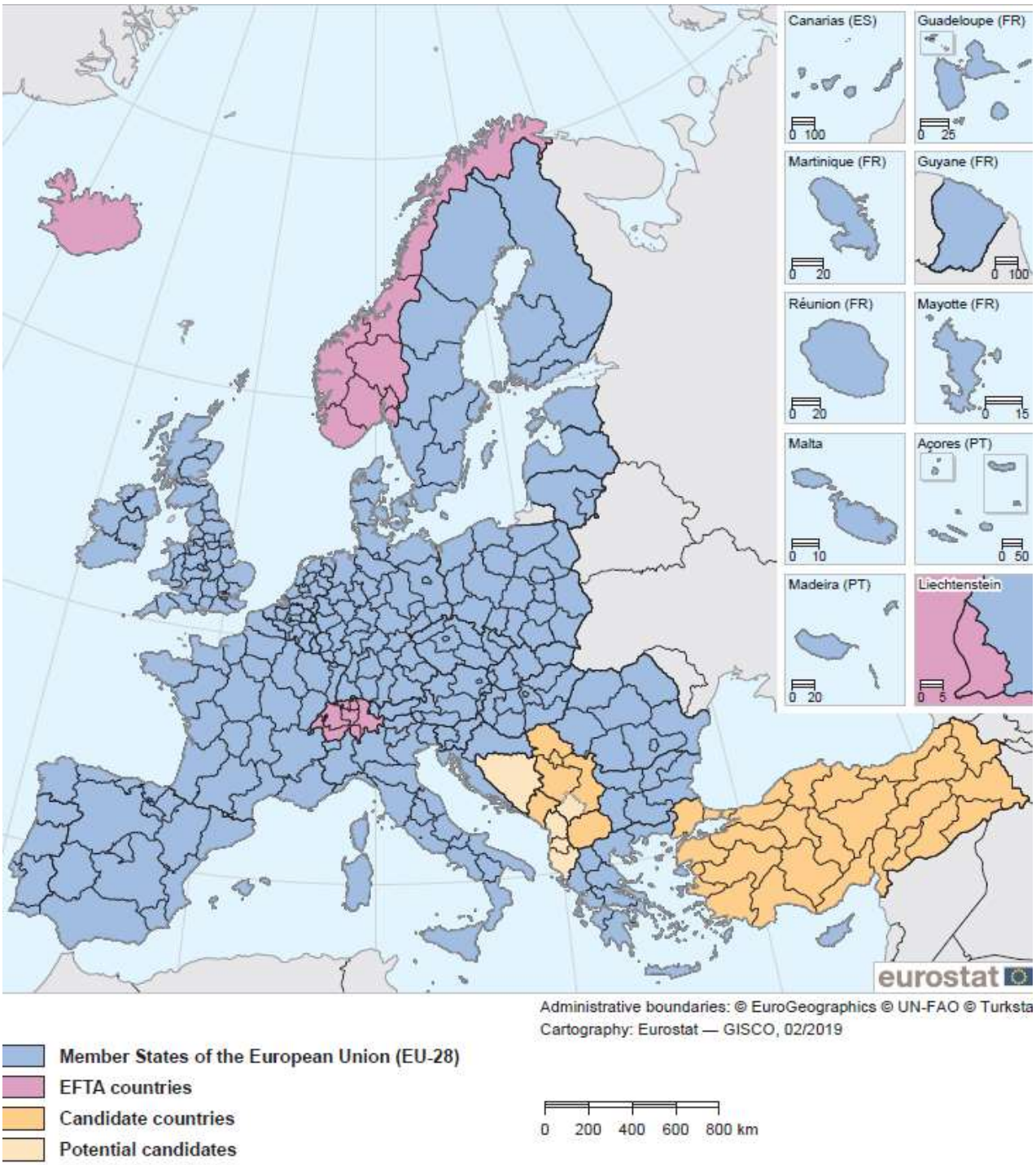

Figure 13: NUTS 2 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016

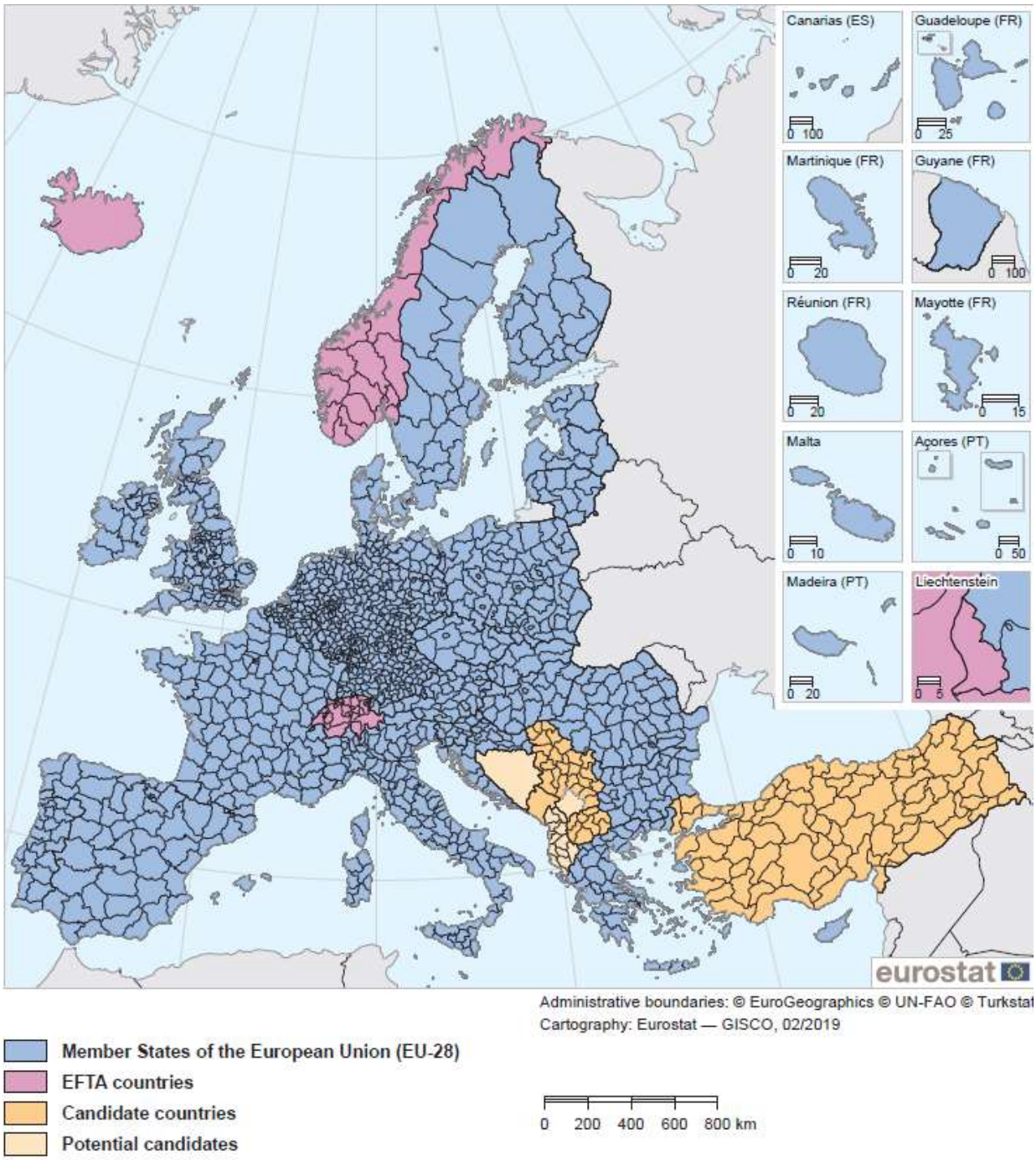

Figure 14: NUTS 3 regions in the Member States of the European Union (EU-28; in blue) according to NUTS 2016

10 Annex B: Types of Legal Entities

Possible types of organisational structures that the HEIMDALL provider could take, and their characteristics are given below:

- **HEIMDALL commercial organisation**: scalable modular system providing integrated services with a particular skill set, strategy, resources as different modules, designed to turn a profit of the platform. Any residual income left over after system implementation expenses, is available to be distributed to shareholders or reinvested back into the HEIMDALL platform at HEIMDALL administration's discretion.
- **Executive agency**: HEIMDALL established as an agency that takes part of the executive branch of government. Is a part of a government department that is treated separately from a managerial and budgetary perspective. HEIMDALL would be “machinery of government” devices distinct both from non-ministerial government departments and non-departmental public bodies. Several other countries have an executive agency model.
- **An intergovernmental organisation (or international governmental organisation; IGO)**: In this context, the HEIMDALL provider would be a structure based on a formal instrument of agreement between nations (e.g. the United Nations, the EU). It is an organisation composed primarily of sovereign states (referred to as member states), or of other intergovernmental organisations. Intergovernmental organisations are often called international organisations, although that term may also include international non-governmental organisations, such as international non-profit organisations or multinational corporations. Intergovernmental organisations are an important aspect of public international law. IGOs are established by a treaty that acts as a charter creating the group. Treaties are formed when lawful representatives (governments) of several states go through a ratification process, providing the IGO with an international legal personality.
- **Joint Venture Enterprise (JVE)**: It is a business agreement in which HEIMDALL partners could agree to develop, for a finite time, a new entity and new assets by contributing equity. HEIMDALL partners could exercise control over the enterprise and consequently share revenues, expenses and assets. There are other types of companies that HEIMDALL can adopt such as JVE limited by guarantee, joint ventures limited by guarantee with partners holding shares. In European law, the term 'joint-venture' (or joint undertaking) is an elusive legal concept, better defined under the rules of company law. In France, the term 'joint venture' is variously translated as 'association d'entreprises', 'entreprise conjointe', 'coentreprise' or 'entreprise commune'. In Germany, 'joint venture' is better represented as a 'combination of companies' (Konzern).
- A European Economic Interest Grouping: A structure that allows HEIMDALL partners to found a legally independent cooperation entity with the aim of facilitating, streamlining and developing their economic activities. The partnership must be related to the economic activity of its consortium member companies and must play a supporting role (e.g. joint accounting or prospecting). This form of association cannot be used to found a new enterprise or to combine all the activities of its members. European Economic Interest Groupings (EEIGs) enable HEIMDALL consortium companies from different EU member states to work together. An EEIG, which has a separate identity from its members, exists to support its members' economic activities. It can be set up and operate in any EU member state and is subject to EU and national competition laws.

  <u>What HEIMDALL could not do</u>

An EEIG must be formed to support the economic activities of its HEIMDALL members and not the EEIG itself. As a result, an EEIG cannot:

- be primarily formed in order to make a profit - although if in carrying out its activities it makes a profit, this is acceptable
- control activities of its members, or of any other undertaking
- hold shares in any of its members
- take investment from the public
- be a member of another EEIG
- employ more than 500 people
- Violate national laws about lending money to a company director or any connected person and transferring money between a company and a director or any connected person.

- A public–private partnership (PPP): HEIMDALL as a government service or private business venture, which is funded and operated through a partnership of government and the private companies of the HEIMDALL consortium. These schemes are sometimes referred to as PPP or P3.

  PPP involves a contract between a public sector authority and HEIMDALL private party, in which the HEIMDALL provides a public service and assumes substantial financial, technical and operational risk in the project. In some types of PPP, the cost of using the service is borne exclusively by the users of the service and not by the taxpayer.

  In other types (notably the private finance initiative), capital investment is made by the private sector, HEIMDALL in this case, on the basis of a contract with the government to provide agreed services and the cost of providing the multi-hazard platform service is borne wholly or in part by the government. Government contributions to a PPP may also be in kind (notably the transfer of existing assets). In projects that are aimed at creating public goods, the government may provide a capital subsidy in the form of a one-time grant, so as to make it more attractive to the HEIMDALL investors. In some other cases, the government may support the project by providing revenue subsidies, including tax breaks or by removing guaranteed annual revenues for a fixed time period.

  There are usually two fundamental drivers for PPPs. Firstly, PPPs are claimed to enable the public sector to harness the expertise and efficiencies that the private sector as HEIMDALL can bring to the delivery of certain facilities and services traditionally procured and delivered by the public sector. Secondly, a PPP is structured so that the public sector body seeking to make a capital investment does not incur any borrowing. Rather, the PPP borrowing is incurred by the HEIMDALL vehicle implementing the project. On PPP projects where the cost of using the service is intended to be borne exclusively by the end-user, the PPP is, from the public sector's perspective, an "off-balance sheet" method of financing the delivery of new or refurbished public sector assets. On PPP projects where the public sector intends to compensate the HEIMDALL through availability payments once the facility is established or renewed, the financing is, from the public sector's perspective, "on-balance sheet", however the public sector will regularly benefit from significantly deferred cash flows.

  Typically, a private sector consortium as HEIMDALL forms a special company called a "special purpose vehicle" (SPV) to develop, build, maintain and operate the asset for the contracted period. In cases where the government has invested in the project, it is typically (but not always) allotted an equity share in the SPV.

- A non-governmental organisation (NGO): a non-governmental organisation (NGO) is a citizen-based association that operates independently of government, usually to deliver resources or serve some social or political purpose. In the HEIMDALL case, it is difficult to operate independently from emergency services of the government. The World Bank classifies NGOs as either operational NGOs, which are primarily concerned with development projects, or advocacy NGOs, which are primarily concerned with promoting a cause. Variations of NGOs include:
    - BINGO (business-friendly international NGO or big international NGO); the Red Cross [28] is one example of a BINGO.
    - ENGO (environmental NGO); the World Wildlife Fund [30] is one example of an ENGO.
    - GONGO (government-operated NGO), by definition not an NGO but an organisation created by a government to resemble an NGO to further some agenda.
    - INGO (international NGO); Oxfam [31] is one example of an INGO.
    - QUANGO (quasi-autonomous NGO), an NGO which may have some governmental members; the ISO [32] is one example of a QUANGO.
    - RINGO (religious international NGO); the Catholic Relief Services is one example of a RINGO.

Other NGO acronyms include DONGO (Donor Organized NGO), TANGO (technical assistance NGO) and MANGO (market advocacy NGO).

End of document