

HEIMDALL: a Technological Solution for Wildfires and Multi-hazard Management Support

Stéphanie Battiston¹, Monika Friedemann², Daniel Milla Gascón³, Alberto Viseras², Adrián Cardil⁴, Miguel Mendes⁴, Jordi Vendrell⁵, Benjamin Barth², Edgar Nebot⁶, Stephen Clandillon¹

¹ UNISTRA ICube-SERTIT, Strasbourg, FR, s.battiston@unistra.fr, s.clandillon@unistra.fr

² German Aerospace Center, Munich, DE, Monika.Friedemann@dlr.de, Alberto.ViserasRuiz@dlr.de, Benjamin.Barth@dlr.de

³ Generalitat de Catalunya, Directorate for Police Coordination, Barcelona, ES, dmillag@gencat.cat

⁴ Tecnosylva, León, ES, acardil@tecnosylva.com, mmendes@tecnosylva.com

⁵ Pau Costa Foundation, Barcelona, ES, jvendrell@paucofoundation.org

⁶ Generalitat de Catalunya, Firefighting Unit, Barcelona, ES, eneboth@gencat.cat

Keywords: cooperation; cross-border; disaster management; platform; preparedness; response planning; scenario

Context of the HEIMDALL Solution

Managing forest fires and other disasters usually involves multiple emergency management organisations, even multiple jurisdictions and countries in case of cross-border events. Following the initial disaster event, cascading effects can further amplify the degree and complexity of disaster situations. This imposes a high need and degree of cross-organisational communication and cooperation, not only during response but also in the preparedness phase, between all stakeholders - from command and control centres, civil protection units and medical services, to police and fire fighting units. However, relevant studies have revealed that collective interoperability is not sufficiently achieved, which reduces the ability to perform collaborative activities, including decision making and action implementation (House, 2014). Moreover, information overload and uncertainty in a crisis situation lead to reduced situation awareness and decision making capabilities.

Managing disasters begins before the disaster happens through being ready and aware of hazards, considering risks, possibilities and preventive measures, building scenarios and training. There is clearly a need to ensure efficient societal preparedness, to improve incident and emergency situation response mechanisms, in order to reduce impacts on people, property, the environment, and on society as a whole. An element of this improvement should be the provision to disaster risk management first responders of a flexible platform for multi-hazard emergency planning and management. Such a platform makes use of innovative technologies, for the definition of realistic multi-disciplinary scenarios and response plans. Implementing such a tool is the ambition of the HEIMDALL H2020 European project (HEIMDALL, 2017).

A Multi-Hazard Cooperative Management Platform

The Horizon 2020-funded project's name HEIMDALL stands for Multi-Hazard Cooperative Management Tool for Data Exchange, Response Planning and Scenario Building. HEIMDALL aims to improve immediate and long-term collaborative strategic planning on a regional scale among the many affected disaster risk management and response stakeholders. The objective is to design and provide decision makers, and other stakeholders, a platform offering a wide range of tools to support emergency management, and in particular different activities in the response planning process for complex multi-hazard crisis situations which involve scenarios (Friedemann, 2018). The main solutions that have been designed and implemented include the: (a) support in the creation, analysis and exchange of realistic multi-disciplinary disaster scenarios, (b) provision of more, better, clearer and validated data, (c) recording of conditions, actual events and actions as the situation evolves, (d) analysis of possible futures of a situation and potential consequences to assess the effectiveness of potential working strategies and identify options and contingencies, (e) evaluation and revision of response plans based on lessons learnt from disasters, (f) inter- and cross-organizational communication and sharing of existing knowledge, situational information, disaster scenarios, strategies and response plans including communication to the public. Domain standards are respected where applicable.

HEIMDALL project results are the fruit of a wide variety of technological specialists and potential end-users collaborating. End users from medical emergency services, police and firefighting units, civil protection, command and control centres from different organisations, disciplines and European countries are participating in the project. This enables the platform to address as best as possible the requirements of the different actors involved in disaster risk management. The project addresses some of the main disaster types regularly affecting European countries – forest fires, floods and landslides – including scenarios of cross-border incidents, multi-disciplinary events, inter-organisational cooperation and population awareness.

HEIMDALL Services

The system is designed as an integrated service platform using various data sources as inputs and proposing a set of services that can be useful to control centres, first responders and local populations during the preparedness and response phases (fig 1).

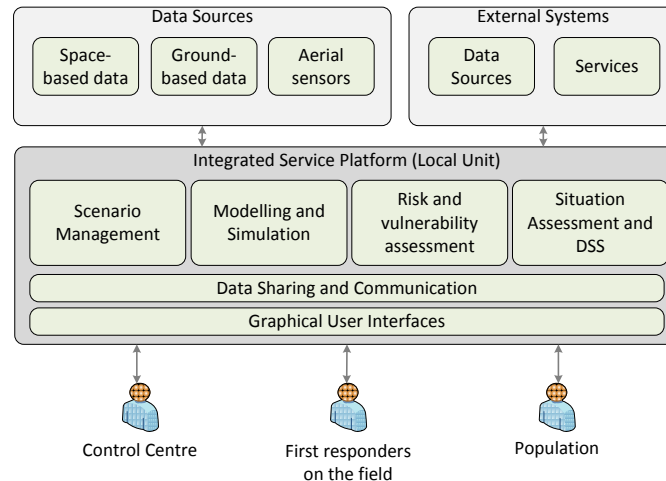


Fig 1. HEIMDALL functional architecture
Source: HEIMDALL deliverable D2.12 (April 2018)

The platform integrates space-based, ground-based and aerial-based data in order to forecast and monitor disaster events. In the case of wildfires, products highlighting burn scar and hot spots over wide areas are provided thanks to satellite and drone data. External data sources and services, including crowdsourcing and field responders' own data, can also be major inputs.

Scenario management is one of the services offered by the system; it aims at supporting decision makers in building, storing, reviewing and comparing realistic and multidisciplinary scenarios and in tracking decisions, measures taken and lessons learnt. Modelling and simulation are dedicated to forecasting hazard behaviour based on the existing input data. The risk and vulnerability service supports the platform with specific products based on Earth Observation (EO) data and simulated models, assessing the consequences of a situation in terms of both physical and human exposure and impacts. Situation assessment functionality integrates all relevant information sources to provide a sound and clear composite picture of the evolving situation, including a standards-based situation summary for overview and sharing. Decision support generates the information base for decisions related to response-oriented tasks such as contingency management; these functionalities combined will provide the possibility for the end users to perform an analysis of different possible scenarios, e.g. worst-case assumptions.

Communication mechanisms and technologies support information sharing among the relevant stakeholders, including first responders deployed on the field and the population at risk. Satellite-based connectivity in remote areas will be provided where terrestrial alternatives are unavailable enabling communication between first responders in the field and back and forth with the control centre. Information can also be shared with other authorities, neighbouring municipalities and countries.

HEIMDALL and Wildfire Management

Today, EO data have largely demonstrated their potential in disaster management, and are widely used by the decision makers in case of forest fires, in particular through operational emergency management mechanisms, e.g. Copernicus Emergency Management Service (EMS) Rapid Mapping. The HEIMDALL platform integrates this kind of data in order to generate and provide reliable and high-quality services highlighting the extent of the burnt areas, fire hotspots, and their monitoring.

Within HEIMDALL, drones are tasked with enabling an operator to monitor an area or a hazard during events such as search and rescue missions, or wildfire front tracking. In particular, a target is monitoring hotspots that may remain after a fire in a local area, and that could reignite. The proposed solution has the following key ingredients: (i) a swarm instead of single drones, increasing the system's efficiency and robustness, and (ii) the development of a fully autonomous system. This implies that an operator would have little intervention with the drones carrying out their assigned task.

The fire simulation and modelling component of HEIMDALL characterises and predicts fire spread and behaviour in diverse and complex fire conditions. Strategies and tactics to suppress wildland fires depend, in fact, on fire analysis which is generally based on fire simulations. In this sense, many agencies worldwide rely on Wildfire Analyst to conduct their analysis in real-time, as a part of a set of innovative propagation modes, including real time fire data assimilation, evacuation time zones, impact

analysis, burn probability analysis, behaviour diagrams, safety zones and crew mobility analysis, etc. All this information combined with expert knowledge improves the decision-making process of the first responders and incident commanders.

Benefits of HEIMDALL from the point of view of the first responders

The complexity of natural disasters is evident. In this sense, HEIMDALL offers facilities and benefits to both preparedness and response phases, and furthermore within the three different levels of response: strategic, tactical and operational. HEIMDALL services and tools are designed, by gathering user expectations and requirements in a collaborative design methodology, to cover the various needs of emergency management actors. In the preparedness phase, the system allows users to store and share scenarios with other authorities which are built on hazardous situation conditions (weather data, wildfire risk indexes, etc.) and which might lead into an incident. These scenarios are based on user experience and allow them to associate lessons learnt from specific incidents and incident action plans. During the response phase, at a strategic level, the possibilities offered by HEIMDALL allow command and control centres to have a global view of the incident in real time. By making use of modelling and simulation tools, combined with data fusion techniques, HEIMDALL provides a better understanding and an improved situation assessment which includes associated vulnerability. In this way, the incident commander can evaluate the resources available, the objectives set, record the actions carried out, monitor operations and the situation at a strategic level and cooperate with other agencies through agreed coordination protocols and previously established channels.

At an operational and tactical level, an incident commander will have real-time information about the situation, its evolution and possible impacts on assets or people. This facilitates decision making and the evaluation of the applied strategy's effectiveness.

Through HEIMDALL the first responders in the field have real-time information concerning the risk, allowing them to take the necessary measures to improve care and safety. In addition, they can not only evaluate the incident action plan and the progress of tactical objectives, but they can also enrich the repository of the platform with lessons learnt and scenario information, making future actions more effective. Furthermore, first responders can improve operations through emergency drills, a possibility offered by the platform through simulators and scenario creation. Another important emergency management aspect to consider is the communication strategy. Hence, HEIMDALL provides reliable information to share with politicians, media or population.

In conclusion, natural destructive phenomena cannot be avoided but the consequences and the negative impact can be reduced. Through technology, HEIMDALL aims to facilitate cooperation and coordination among agencies, assisting them with the best information to prevent and, in any case, act, respond and effectively plus efficiently manage emergencies caused by natural disasters. In this way, not only is preparation and response improved, but also the capacity for recovery and adaptation enhanced.

Perspectives

A first version of the platform was validated in a workshop in October 2018 with various end-users. More releases will follow with the objective to have a pre-operational platform end 2020 which could be used by HEIMDALL's end users, and to extent it to additional users. Moreover, the system can in future be extended for other natural and man-made hazard types.

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 740689.

References:

- Copernicus Emergency Management Service Rapid Mapping, <https://emergency.copernicus.eu/mapping/ems/service-overview>
- Friedemann, M. and al. (2018), Conceptual scenario model for collaborative disaster response planning, *Bungartz, H.-J., Kranzmueller, D., Weinberg, V., Weismueller, J., Wohlgemuth, V. (Eds.): Environmental Informatics: Techniques and Trends, Adjunct Proceedings of the 32nd edition of the EnviroInfo*, 119-125
- HEIMDALL (2017), HEIMDALL - Multi-Hazard Cooperative Management Tool for Data Exchange, Response Planning and Scenario Building, http://cordis.europa.eu/project/rcn/210221_de.html, <http://heimdall-h2020.eu/>
- House, A., Power, N., & Alison, L. (2014), A systematic review of the potential hurdles of interoperability to the emergency services in major incidents: Recommendations for solutions and alternatives, *Cognition, Technology & Work* 16, 3 (August 2014), 319-335.

Presenter's bio:

Stéphanie Battiston is the deputy head of ICube SERTIT's rapid mapping service (University of Strasbourg), highly involved in operational emergency management mechanisms: the Copernicus EMS Rapid Mapping and the International Charter Space and Major Disasters.