

# Improving Resilience to Emergencies through Advanced Cyber Technologies: the I-REACT project

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**Society as a whole is increasingly exposed and vulnerable to natural disasters because extreme weather events, exacerbated by climate change, are becoming more frequent and longer. In this context, the access to an integrated system providing the main emergency management information and data coming from multiple sources is even more critical to successful disaster risk management.**

In the last ten years, natural hazards<sup>1</sup> have caused 2 billion casualties and costed up to \$1.4 trillion worldwide, as registered in the Emergency Events Database (EM-DAT, 2017). In Europe, disasters caused around 7 million casualties and up to €13 billion of overall economic losses in the decade 2007-2017. In this period, flood is the biggest hazard in terms of occurrence, affected people and economic damage in Europe, while the deadliest hazard remains extreme temperature, followed by flood and earthquake. Wildfires are less impacting; however, it ranks second in affected people. Worryingly, extreme weather events will be even more fre-

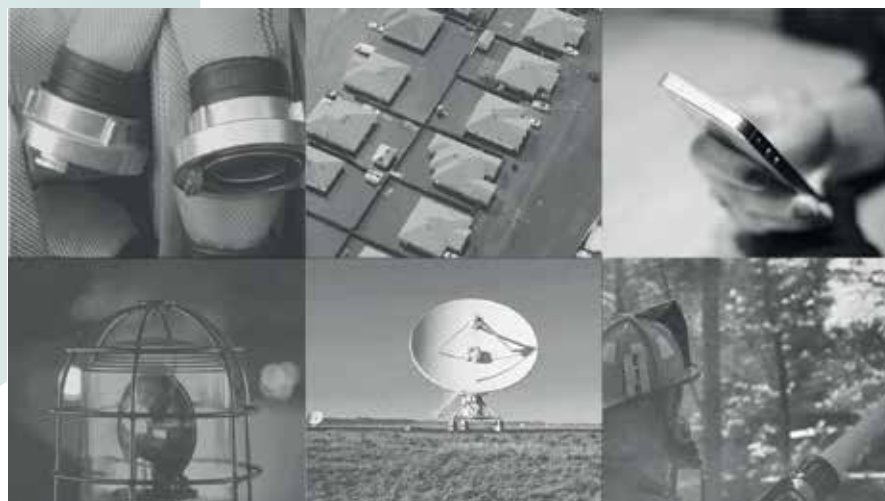


Fig. 1 - The I-REACT project integrates a large number of data sources to fight disasters.

quent and last longer in the future, mainly due to climate change. Greater evaporation will lead to increased water vapour in the atmosphere, producing more intense precipitation. This, together with rapid snow melting, intensifies the likelihood of floods. Also, higher temperatures will increase the frequency of wildfires as well as other natural disasters. According to the Intergovernmental Panel on Climate Change (IPCC, 2013), the surface temperature is projected to rise over the 21st century under all assessed emission scenarios.

The European Commission's Humanitarian Aid and Civil Protection department (ECHO) and the Federal Emergency Management Agency (FEMA) of the United States agree upon the need to invest in disaster prevention. One of the key message in the

2017 ECHO Factsheet stats that “for every € invested in disaster prevention, € to € are saved in disaster response” (ECHO, 2017). According to the “Nature Climate Change” journal, improving flood defences across the EU to prevent 100-year flood would save € billion a year by 2050 but cost only €0.75 billion to implement (Jongman, 2014).

Despite that, current systems for risk management are still limited in their effectiveness. Even if technological progresses are registered and large amounts of data are available, there is no platform that integrates and analyses in real time all the useful data to improve prediction and management of natural disasters. On the other hand, the need for systematic data for disaster mitigation and prevention is an increasing concern for both development and response agencies. In the past, data needs



Fig. 2: The I-REACT partners, advisors and end-users at the International User Requirements Workshop (IURW)

were addressed on an ad hoc basis, which included collecting the information at the time of the emergency. However, there is a growing understanding that data collection, analysis, and management can help both short and long-term development goals and support to identify and address disaster risks. The I-REACT project has been conceived in this context, considering that “you cannot manage what you cannot measure”, as stated by Margareta Wahlström, the United Nations Special Representative of the Secretary-General for Disaster Risk Reduction.

#### The project: I-REACT in brief

I-REACT (Improving Resilience to Emergencies through Advanced Cyber Technologies) is a Horizon 2020 3-year project (2016-2019) funded by the European Commission under the Secure Society Work Programme (DRS-1-2015). I-REACT integrates existing services, both local and European, into a platform that supports the entire emergency management cycle. In particular, I-REACT will implement a multi-hazard system with a focus on floods, fires and extreme weather events, as they are the most impacting natural hazards driven by climate change. To reach this objective, I-REACT brings together a multidisciplinary team of 20

European partners. From researchers and technologists to industry leaders, UN officials, consultants or communicators, these partners are working collaboratively on the different tasks of the project providing their experience and expertise to generate the best solution against disasters. The project is coordinated by the Istituto Superiore Mario Boella of Turin. Consortium partners include: Geoville, Eoxplore, Terranea, Alpha Consult, UNESCO (Regional Bureau for Science and Culture in Europe, Venice), Politecnico di Torino, Celi, JoinPad, Fondazione Bruno Kessler, Finnish Meteorological Institute, Meteosim, Bitgear,

Ansurs Technologies, Technical University of Vienna, Scienseed, CSI Piemonte, Aquobex, Answartech, and Joint Research Centre (JRC) of the European Commission. The project will broaden the scope of its predecessor, a FP7-funded initiative named “Integrating GMES Emergency Services with satellite navigation and communication for establishing a flood information service” (FLOODIS<sup>2</sup>), which already involved some of I-REACT partners. Ended in 2015, FLOODIS focused on implementing a crowd-sourcing approach to support the emergency response in case of floods with dedicated demonstrations carried out in Italy and

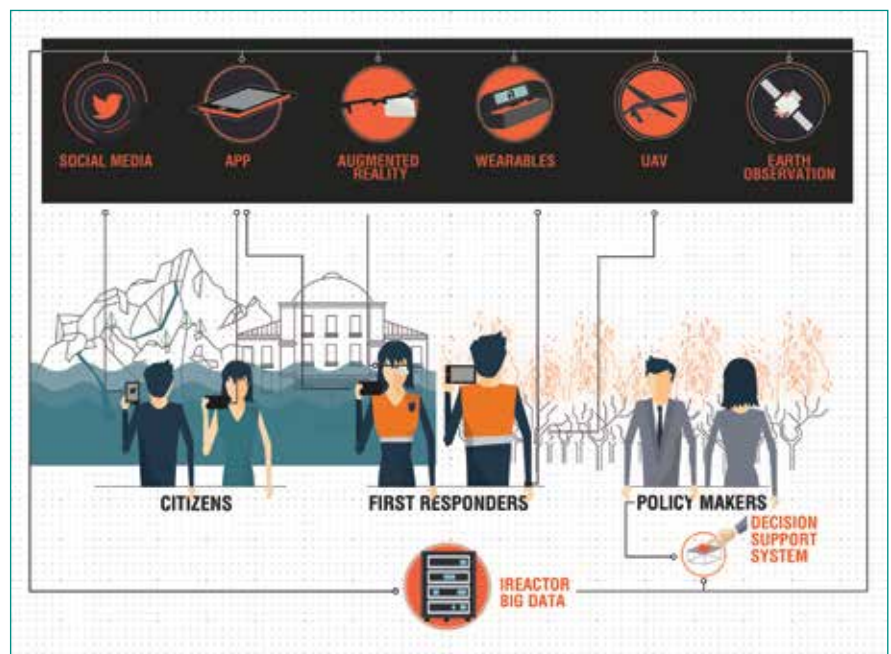


Fig. 3 - The project empowers different stakeholders with several new technologies and essential information to improve the fight against disasters.

in Albania. FLOODIS implemented a smartphone application to collect real-time reports from both citizens and civil protection agents, and to provide short and long-term projections of the flood extent for supporting in-field emergency rescue units. I-REACT extends this approach, multiplying the opportunities and serving as a tool during all the three emergency management phases, i.e. prevention, preparedness and response phases.

The first one mainly deals with the preparation of a community to eliminate or reduce the impact of future disasters. For this, the I-REACT platform will integrate historical data, real-time reports, weather data and satellites observations to derive detailed statistics and accurate risk maps. These maps, coupled with a decision support system, will allow decision makers to effectively plan prevention measures aimed at increasing the resilience to future disasters. The second is the preparedness phase. During this phase, the coordination between governments, civil organizations and citizens will be promoted to be prepared in case of an emergency. To reach this objective, I-REACT will analyse weather

forecasts, data from both local and European early warning systems, such as the European Flood Awareness System (EFAS) and the European Forest Fire Information (EFFIS), and warnings extracted from social media or received through crowdsourced reports from authorities and citizens, as well as using the I-REACT mobile application. The third one is the emergency response phase, in which an effective reaction, first aid and evacuation are crucial. To help on-site operators, I-REACT will allow to get a quick and complete operational picture thanks to the ingestion of real-time reporting (from mobile phones or wearable devices) and its integration in nowcast and forecast models. To improve self-protection behaviour and reduce exposure, I-REACT will support public authorities to immediately warn citizens with real-time information and instructions.

#### Where we are: I-REACT at its second year

The project officially started at the beginning of June 2016 and it is now entering its second year.

The innovation design phase,

based on a user-centred design and including the requirement definition, is concluded. Within this activity, the international workshop “Increasing Resilience to Natural hazards through Information and Communication Technology” was organised on 14-15 September 2016 at UNESCO Headquarters in Paris. It brought together policy-makers, emergency service providers and science and technology experts from different European countries. The workshop aimed at gathering their needs, assess the implementation gaps in their operational procedures, and co-design some key features of the I-REACT system, e.g. the data collection and visualization process. Also, a survey to gain knowledge on citizen’s perception of risks was launched. The results have been used to design tips and quizzes that will be inserted in the mobile application to improve citizen’s risk awareness in all phases of the emergency.

The three main technical work packages, based on a “Plan-Do-Test” agile approach, are still on-going. More in detail, they foresee the integration of external services and data, such as the Copernicus Emergency Management Service (EMS), open data, Sentinel satellites, EGNSS and historical information. At the same time, up to March 2018, the team will deliver all main models of I-REACT (modelling and engines), including weather and climate forecasts, extreme weather event detection, flood and fire nowcast and forecast, risk forecasts, and a social media data engine. Last, but not least, the service oriented architecture stage has started, which is aimed at the implementation of the centralized system archi-

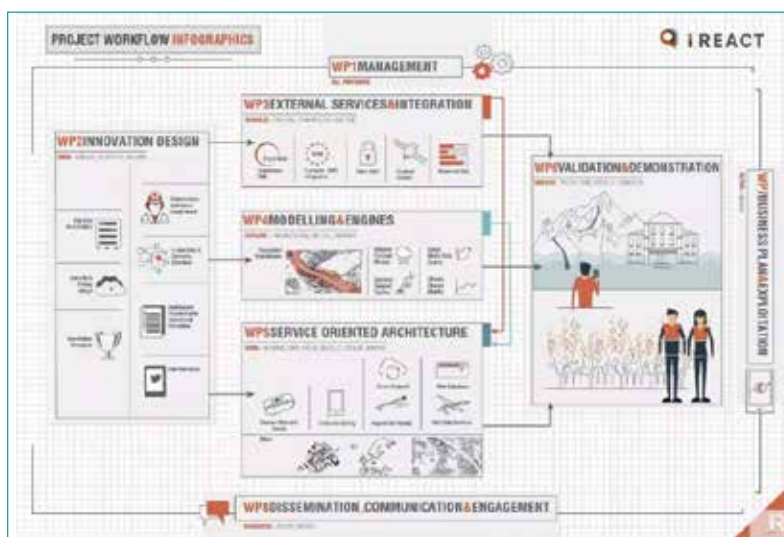


Fig. 4 - The I-REACT workflow infographics.



ture and of all in-filed technologies for data collection. Since June 2017, the team is approaching other two main activities. First of all, to achieve a full system integration and consolidate the performance of the I-REACT solution, simulations and direct involvement of end-users and emergency responders are foreseen during the validation and demonstration phase. At the moment, five demonstrations (in Italy, Spain, Finland, UK, Malta) have been planned. After each demonstration, a user workshop will be organized to gather feedback that will be used to improve (tune) the system. Second, the business assessment and exploitation phase recently kicked-off, including a costs-benefits analysis, business plan, implementation roadmap and exploitation activities aimed at assessing I-REACT socio-economic impact and preparing its roll-out.

The project workflow is completed by the overall project management and the dissemination, communication and engagement phase, both lasting for the overall project duration. Thanks to this second activity, I-REACT is now present in different on-line channels (e.g. website, Facebook, Twitter, YouTube) and promoted through several materials (e.g. videos, infographics).

#### **Where we want to be: I-REACT final goal**

“By 2018, I-REACT will implement a European-wide platform that integrates emergency management data coming from multiple sources. In this way, we will be able to produce information faster and allow citizens, civil protection services and policymakers to effectively react to natural disasters and

mitigate their impact on the society”, says Claudio Rossi, Project Manager at ISMB, who is in charge of the project management and the technical coordination. How? Leveraging on innovative cyber technologies and ICT systems, the I-REACT platform will be designed as an articulated and modular system based on different components. As mentioned before, it will integrate many different information sources, including Copernicus EMS maps, early warnings from the EFAS and EFFIS, satellite data (Sentinel), social media streams and crowdsourced information from emergency responders and citizens. All this information will be merged to provide added-value products, such as a decision-support system for authorities and an app for citizens. Also, wearable devices and smart glasses will be provided to first-responders, who will benefit from high-precision positioning thanks to Galileo and EGNOS and Augmented Reality to make hands-free reports.

Thanks to this architecture, I-REACT will be able to provide greater emergency anticipation through accurate weath-

er forecasts that, coupled with historical knowledge, satellite and risk maps, crowdsourced reports, and social media information will allow to better anticipate extreme weather events, floods, and fire. The modularity of the system, and its interoperability with existing systems, will allow a strong flexibility of the platform in terms of future exploitation, making it able to answer to different market needs.

#### **Our target: I-REACT as a multi-user platform**

“At I-REACT we want to gather all the participants involved in the different phases of the emergency management, to translate their needs and ideas into effective solutions with a real social impact. We collaborate with groups of end users that will benefit from the I-REACT technology and can provide first-hand experience. We also have a strong advisory board that provides valuable counselling and support” explains Claudia Maltoni, Project Manager at Alpha Consult, the SME in charge of project business assessment and exploitation.

Even if mainly addressing



**Fig. 5 - 3D model of the first responder's wearable for improved positioning and environmental sensing.**



emergency management, the proposed system has been conceived as a multi-user platform as well. It mainly targets public administration authorities, but also private companies, as well as citizens in order to provide increased resilience to natural disasters.

A Costs-Benefits Analysis (CBA) conducted by ALPHA Consult during the FLOODIS project and based on tests undertaken together with Civil Protections, namely in Veneto Region and Albania, provides some interesting preliminary inputs. Key impacts<sup>3</sup> has been described and quantified with respect to the functionalities of the system for both emergency managers and the society as a whole. Specifically, in the two case studies<sup>4</sup>, a final saving of c. €5,8 million for Albania and €9 million for Treviso could have been achieved, in case of having FLOODIS in place. These benefits are mainly driven by decreasing costs for emergency management operations, less damages to productive sectors, assets, properties and infrastructures, together with a reduction of affected people. It is worth noting that these estimations are not negligible. As a consequence of the overall project results and impact assessment, FLOODIS has been finally integrated with DEWETRA, a real-time system for hydro-meteorological and wildfire risk forecasting, monitoring and prevention in use in Albania. At the same time, these

impacts are clearly conservative with respect to the much higher potential of I-REACT.

Besides the benefits brought by the proposed solution to organisations in charge of disaster management, governments and society as a whole, I-REACT could foster market growth and produce impacts for other private stakeholders, such as current system providers, insurance companies and third parties with an interest on information produced by I-REACT. For this reason, “a set of interviews are being carried out with different types of private actors, from insurance companies to firms specialised on business continuity and disaster recovery, in different countries in Europe to assess their requirements and interest in I-REACT. A dedicated CBA could be undertaken to quantify potential benefits also in some relevant private sectors”, concludes Maltoni.

## NOTES

- 1 Drought, earthquake, extreme temperature, flood, landslide, storm, volcanic activity, mass movement and wildfire are considered
- 2 [www.floodis.eu](http://www.floodis.eu)
- 3 Reduction of costs for emergency management operations, human losses, affected people, infrastructure damages and damages to private sector activities, environment, housing and education buildings and cultural heritage have been all assessed.
- 4 The 2015 flood in Albania and water bomb in Treviso.

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## KEYWORDS

I-REACT; NATURAL HAZARDS; CLIMATE CHANGE; DISASTER MANAGEMENT; COPERNICUS

## ABSTRACT

Due to climate change, floods, wildfires and other extreme weather events are becoming more frequent and intense. This scenario poses a challenge for current risk management systems. I-REACT project aims to develop a solution through the integration and modelling of data coming multiple sources. Information from European monitoring systems, earth observations, historical information and weather forecasts will be combined with data gathered by new technological developments created by I-REACT. These include a mobile app and a social media analysis tool to account for real-time crowdsourced information, wearables to improve positioning, as well as augmented reality glasses to facilitate reporting and information visualisation by first responders. With this approach, I-REACT will be able to empower stakeholders in the prevention and management of disasters. Citizens will be involved in reporting first-hand information, policymakers will be supported in the decision-making process, and first responders will be equipped with essential tools for early warning and response. At the same time, private companies could leverage specific set of I-REACT components to improve their business, when linked to disaster management. Overall, I-REACT aims to be a European-wide contribution to build more secure and resilient societies to disasters.

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