PPDR Information Systems – A Current Status Review Report

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ABSTRACT

Public safety organizations include emergency and law enforcement agencies, fire departments, rescue squads, and Emergency Medical Services (EMS). In response to increasing threats of terrorism and natural disasters, safety and security personnel must overcome technology barriers to enhance their efficiency, especially in the neuralgic section of information exchange. Limited availability of information hinders the response time and decision making process. Efficient communications supported by interoperable technology are vital to the situational awareness, scalability, and effectiveness of incident response. This paper's prime objective is the review of available information systems than can be used to support and assist security agencies.

Keywords

Information Systems, Disaster Management, Disaster Preparedness, Early Warning Systems

INTRODUCTION

The frequency and intensity of natural or man-induced disasters have increased over the last few decades, accounting for great cost of lifes and commodities. Public Protection and Disaster Relief (PPDR) agencies, also known as first responders, are the primary forces that deal with incident response. These agencies operate in a hierarchical structure where high level officers take the decisions and coordinate the actions of the operation.

A key parameter to an incident response is the fast transmission and processing of data derived from the field of operation. Although communication systems are an integral part of PPDR agencies, interoperability between the different PPDR communication systems may not be feasible in most cases. This radically hinters the decision making process and the effectiveness of the human resources.

This paper reviews the Information Systems known to support PPDR agencies in the field or can help prevent or predict an upcoming disaster. This is the first paper that reviews all the known information systems presently utilized.

INFORMATION SYSTEMS

The European Forest Fire Information System (EFFIS)

EFFIS supports the prevention, preparedness, post-fire evaluation and firefighting of wildfires in European level, it became operational in 2000 by the Joint Research Centre (JRC) and the Directorate General for Environment (DG ENV).

EFFIS supports an on-line system, a database regarding wildfires in EU and produces reports on wildfires, in annual base. During the fire season, EFFIS produces fire forecasts for up to six days, twice every day these forecasts are processed through emails in the relative departments and civil protection agencies of the Member States of EU. The "up-to-date situation" interface provides real time information (e.g. hot spots maps) during the fire season as well "*as tools providing maps of fire danger anomalies and absolute ranking based on the fire danger index adopted"* [1]. Moreover, EFFIS offers several applications such as ***Current Situation, Long-term fire weather forecasts, Fire History*** and ***Fire news***, as explained below.

Current Situation produces fire forecasts up to six days during the fire season, for Europe and the Mediterranean area. The maps regarding the hot spots and fire perimeter are updated in daily basis. However, this application has some drawbacks; namely, the location of a hotspot in the map is accurate within a distance of 1.5km, the MODIS sensors cannot detect exclusively fires and hotspots but also any other heat source; furthermore it might not detect small fires or fires covers by smoke or clouds. Therefore, care must be taken while using this application [2].

Long-term fire weather forecasts offers two forecast functionalities for European and Mediterranean areas; these are:

- *Seasonal forecast of temperature and rainfall anomalies*, an experimental product which produces forecast maps for the two succeeding months except during the fire season where it produces monthly forecast maps.
- *Monthly forecast of temperature and rainfall anomalies*, also an experimental tool producing forecast maps for two weeks in advance in regular season and every week during the fire season.

Fire History provides access to all fire incidents occurred from 1980 until 2011 in Europe. All the relevant information are stored in the *European Fire Database* [2].

Through the ***Fire News*** application the users can search for news regarding wildfires based on the location and the date they are interested for.

EFFIS is composed of five modules, the Fire Danger Forecast, the Active Fire Detection, the Rapid Damage Assessment, Fire Damage Assessment (RDA) and the European Fire Database.

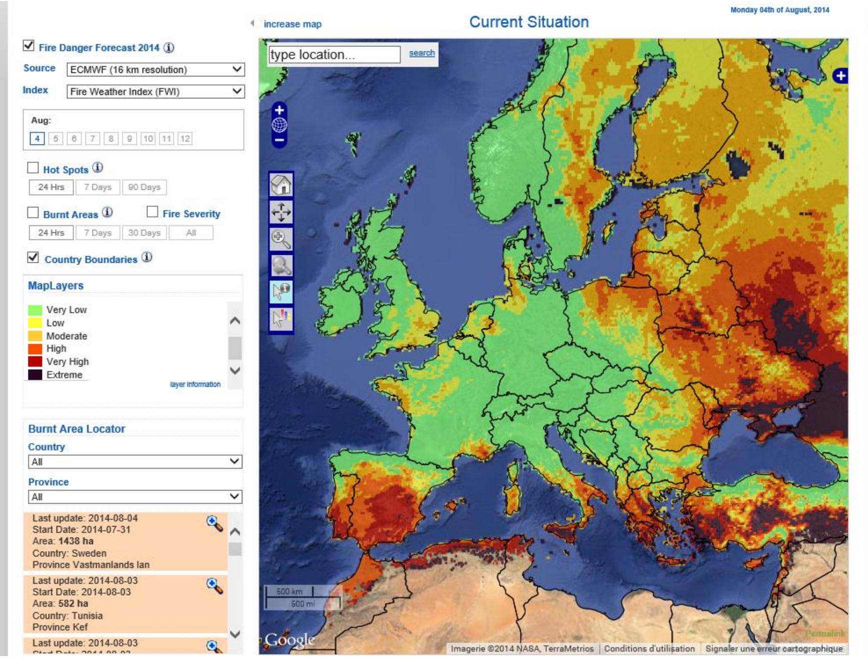

Figure 1 EFFIS Current Situation interface

The ***Fire Danger Forecast*** currently in test mode, produces daily maps for up to six days spanning over an eight month period, from the 1st of March until the 31st of October. As an input it uses forecast data from the Meteo-French (MF) and the German meteorological services (DWD).The categorization on the maps produced by the Fire Danger Forecast are composed by six classes as depicted in table 1, with a spatial resolution of about 10 km (MF data) and 36 km (DWD data) [3].

Fire Danger Classes	FWI ranges (upper bound excluded)
Very low	< 5.2
Low	5.2 - 11.2
Moderate	11.2 - 21.3
High	21.3 - 38.0
Very high	38.0 - 50.0
Extreme	>= 50.0

Table 1 Fire Danger Forecast Classes [3]

The ***Active Fire Detection*** module identifies active fires based on the hotspots produced by MODIS sensor and was implemented in 2007 supporting the Monitoring and Information Center (MIC). Information regarding active fires are updated on a daily basis and if necessary every three hours from the acquisition time of the images produced by the MODIS sensors. In order to minimize false alarms a knowledge based algorithm has been implemented accounting the land cover categories of the surrounded area, the confidence level of the hotspot and the distance between the hotspot and metropolitan areas as well as the distance with man-made surfaces [4].

RDA maps the burned area during the fire season (June-September) based on the images produced in daily bases from the MODIS sensors. RDA takes into account only burned areas by fires equal or larger than 40 ha. [5].

The ***Fire Damage Assessment*** module is mapping the burned areas due to wildfires at the end of the fire season, based on images produced by Wide Field Sensor (WiFS) of 180m ground spatial resolution. However, the image resolution was not sufficient and even though it was improved at 32m ground spatial resolution, the development on ***RDA*** module has been postponed for the time being, awaiting further input [6].

The ***European Fire Database*** contains data and information regarding forest fires provided by twenty one EU Member States on annual bases since 2004 [7].

Further to the aforementioned, the EFFIS team is currently developing two additional modules, the ***Post-fire vegetation regeneration*** and the ***Post-fire soil risk***. Once the ***Post-fire vegetation*** *regeneration* module is complete, EFFIS will be able to evaluate the vegetation recovery in areas damaged by fires; this will be achieved by comparing images, acquired by satellites of the area, before and after the fire. The ***Post-fire soil risk*** module will estimate any potential soil loss and corrosion in burnt areas and pin pointing the areas requiring urgent prevention actions [8].

European Flood Awareness System (EFAS)

EFAS is the pan-European early flood warning system which became part of the Emergency Management Service of Copernicus Initial Operations in 2011; this Information System has been fully operational since October of 2012. EFAS's three main operational goals are, i) to add value in early flood forecasting products and hydrological services, ii) to build a network of operational hydrological services in Europe and iii) to provide early warning pan-European overview products (e.g. maps) for forecast floods up to fifteen days in advance and for ongoing floods [9].

EFAS apart from providing information about ongoing and forecast floods it created a prototype archive which is available to the public, while real-time monitoring is only accessible to registered users, allocated from the respective national/regional forecasting centers; the latest can check for forecasts every day, using the Web interface of EFAS by providing their credential [10].

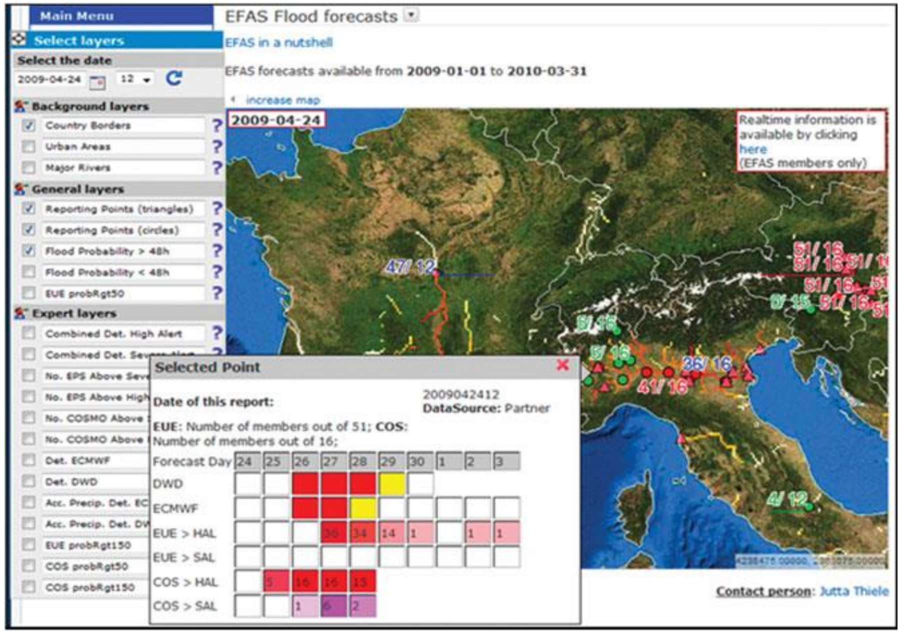

Figure 2 EFAS flood forecasts interface [10]

Based on Bartholmes et al [11], the two most important flood alerts of EFAS are:

"Severe alert level (SAL) threshold:

– *Very high possibility of flooding, potentially severe flooding expected*

High alert level (HAL) threshold:

– *High possibility of flooding, bankful conditions or higher expected"*

The data produced from the European Centre for Medium-Range Weather Forecasts (ECMWF) and the German Weather Service (DWD) provide input to EFAS as well as the Ensemble Prediction Systems (EPS) from ECMWF and from the Consortium for Small-scale Modeling (COSMO). The EPS form ECMWF provide the medium-range forecasts up to fifteen days globally, while the EPOS from COSMO provide forecasts up to five days for Europe.

Global Flood Awareness System (GloFAS)

GloFAS is the result of the synergy of JRC with ECMWF of a system alerting of potential flooding events globally [12]. GloFAS utilizes an operational ensemble of stations which exchange near-surface meteorological parameters; it uses datasets including climatology data in order to successfully calculate the possibility of flooding events on daily basis. Figure 3 depicts the distribution of stations used by GloFAS.

Primarily, GloFAS uses the Variable resolution Ensemble Prediction System (VarEPS) which comprises 51 global forecasts sources with to provide a flood prediction range of 32km for 10 days [13]. Furthermore, GloFAS uses global atmospheric analysis which is provided by the ECMWF; the atmospheric monitoring is performed in 80km range and is updated in near real-time. Based on aforementioned inputs, GloFAS simulates for example, the river discharge with the Lisflood hydrological model that supports daily forecasting of regions of 10 km in range. Two types of simulations are conducted in daily basis; these are:

- Daily simulations using the latest VarEPS predictions leading to 51 possible results of stream flows for the selected forecast horizon.
- Using input data since 1990, a climatological simulation derives the daily and annual maxima and thresholds that will be set up for the detection of potential flooding.

One of the most important features of GloFAS is the early warning system which is running operationally since July 2011. A case study has been performed based on the 2010 Pakistan floods which covered approximately one-fifth of the total land area of Pakistan. The prediction of flooding from GloFAS was at 100% percentage accuracy on 28 of July 2010. Hence, early warning is critical in order to prevent or mitigate the risks that rise with a flooding event.

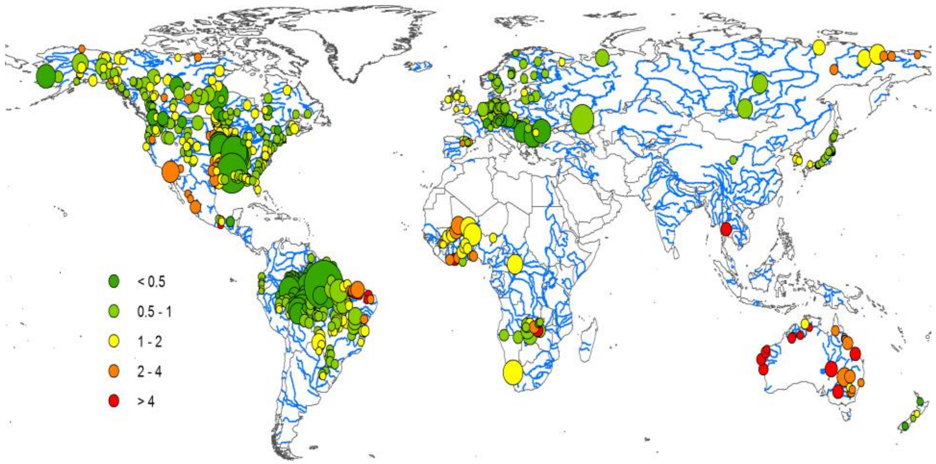

Figure 3 Coefficient of variation of the estimation residuals for the 620 stations considered. Circle size is proportional to the upstream area of the river station [13]

Global Disaster and Coordination System (GDACS)

GDACS is a web-based system, created in 2004 through the collaboration of the United Nations and European Commission. The aim of GDACS is to fill the information as well as the coordination gap during the early phase of a natural disaster (e.g. Earthquakes, floods, tropical cyclones and tsunamis). The GDACS website consists of the following information systems and coordination tools; the **GDACS Disaster Alerts**, **The Virtual On-Site Operations Coordination Center (OSOCC)** and the GDACS **Satellite Mapping** and **Coordination System (SMCS)** [14] [15].

The **GDACS Disaster Alerts** are automatically generated based on specific algorithms and available data to alert of forthcoming disasters. It has four different alert types, White, Green, Orange and Red which are calculated based on specific risk indicators. The main risk indicators which are taken into account are the Severity of the disaster, the Population and the Infrastructure that will be affected by the upcoming disaster and the Vulnerability of the country that will be affected. Moreover, if an alert is generated the subscribed users are notified via Email and SMS [16] [17].

The following table depicts the four alert types generated by GDACS,

Alert Type	Disaster Level	International Assistance
White	Minor	Not required
Green	Moderate	Not likely to be required
Orange	Potential local	Might required
Red	Potential severe	Expected

Table 2 GDACS alert types

Furthermore, it is important to emphasize that the accuracy of the alerts is as accurate as the available information regarding the population and infrastructure of the area that will be affected.

The **Virtual OSOCC** is an online platform, designed to exchange/share structured information in real time and to facilitate the cooperation and coordination of the response teams during the first phase of a disaster. Furthermore, it can also assist decision making process and the analysis of the available information. Access to the platform is granted only to disaster managers working either for governments or response organizations [15] [16].

The users of the GDACS's **SMCS** communication and coordination platform can monitor any mapping activities and inform the stakeholders, during the course of a disaster, using available satellite images and maps provided by numerous organizations such as the United Nations Operational Satellite Applications Programme (UNOSAT).

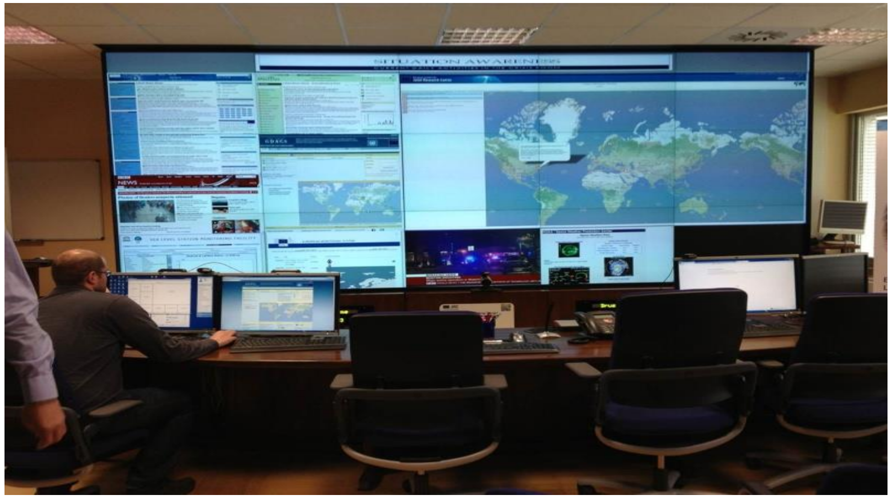

Figure 4 Information Systems in control room

Cisco Open Platform for Safety and Security (COPSS)

COPSS is Cisco's approach to fulfill the needs of the security agencies which enables them to develop solutions for their needs, while ensuring flexibility to the adoption of new-technologies, real-time decision making, and networked command and control. COPSS can be applied to several security fields such as crisis management, urban security, border control, secure public transportation and much more.

COPSS is an architecture framework consisting of six major components: a) Command and control; b) Mission-critical networks; c) Incident Collaboration; d) Sensing and Actuation; e) Mobile force; and f) Citizen-Authority interaction [18]. These components can be combined in order to provide ubiquitous network connectivity by using different communication technologies. For example, the mission-critical network is based on the IP protocol and the access methods which can be used are: a) TETRA; b) WiMax; c) Wi-Fi; d) 3G; and e) satellite communication technologies. Apart from the network connectivity, interoperability is one of the most important functionalities to increase the effectiveness of the Public Protection and Disaster Relief agencies. The incident collaboration building block enables the security teams to communicate using different technologies including IP and analog or digital radio, instant messaging, data and video communications.

In order to enhance the decision making process and respond to emergency incidents, data inputs from multiple entities are required. COPSS uses a fusion center which processes data from multiple sources, monitors the input data, and automatically responds in a case of emergency. It is notable that sensors, biometric technologies for human identification, object identification, real-time video analytics are some of the inputs that are supported by COPSS. Fleet management is another important parameter which has been taken into account [19]. Mobile terminals and vehicle computing devices, are supported which can ensure the effectiveness of the human resources in the field.

CONCLUSION

The rising number of disasters has been a wake-up call for the European institutions; their reaction – on the basis of the Lisbon Treaty, under which the EU is called upon to get organized at a multinational level in order to deal with major catastrophes – has been vigorous and swift. The question, however, is whether it is possible to coordinate with the mosaic of responsibilities and competences for crisis management, and the generation of synergies. Such actions require an infrastructure that supports the transparent data collection, distribution and sharing as well as communication. In this frame, Information Systems are an important tool for all Public Protection and Disaster Relief agencies involved that undoubtedly can assist the effectiveness of handling a disaster, either as preventive or post disaster management.

This report has demonstrated both the crucial aforementioned functionalities that Information Systems accommodate for, a study that has not been carried out in the past. In the cases of disasters, be natural or man-induced, preparedness is the advantage that makes the difference to the response and efficiency. Hence, systems like Global Flood Awareness System (GloFAS) or Global Disaster and Coordination System (GDACS) and European Flood Awareness System (EFAS) are examples of monitoring and early warning systems that can save lives. Other systems dedicated to early stage and post disaster management such as Cisco Open Platform for Safety and Security (COPSS) or The European Forest Fire Information System (EFFIS), support efficient decision making that lead to minimization of the disaster effects. Note that the reported Information Systems are a selection of the multi-disciplinary disaster management field.

In all cases, it is clear that Information Systems are a key piece to the mosaic of the disaster resilience, preparedness and anticipation but also of the post crisis management by providing the information required for efficient coordination and decision making procedures.

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