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# HELP - An Early warning dashboard System, built for the prevention, mitigation and assessment of disasters, with a flexible approach using open data and open source technologies

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## ABSTRACT

**H.E.L.P is an early warning dashboard system** built for the prevention, mitigation and assessment of disasters, be they earthquakes, fires, or meteorological systems.It was built to be easily manageable, customizable and accessible to all users, to facilitate humanitarian and governmental response. In its essence it is an emergency preparedness web tool, which can be used for decision making for a better level of mitigation and response on any level. Risks or disasters are not events in our control, rather, they are situations to which we can better manage with a framework based on preparedness. The earlier and more precise the monitoring of hazards allow for faster response to manage and mitigate a disaster's impact on a society, economy and environment. This is exactly what HELP offers, it plays a main role in the cycle of early warning and risk (Preparedness, Risk, Mitigation, and Resilience). It provides information in **real time** on events and hazards, allowing for the possibility to analyze the situation and find a solution whose outcome protects the most lives and has the least economic impact. As a tool it also provides the opportunity to respond to a hazard with resilience in mind, this means that not only does HELP **prepare for and mitigate events**, it can also be used to **implement better organizational methods** for future events, thus, **minimizing overall risk**. Providing people with the means to better be able to take care of themselves, lessening the effects of future hazards each and every time. HELP is a tool in a framework which was created to support governments in their efforts to protect their people, building their response efficiency and resilience. HELP (with the name of E.W.A.R.E. Early Warning and Awareness of Risks and Emergencies) was born as *WFP* (The World Food Program) and *IMAA-CNR* (Institute of Methodologies for Environmental Analysis of the National Research Council of Italy) entered into a *Cooperation Agreement* concerning the development of a Geo-Spatial Data Infrastructure System for the Palestinian Civil Defense with the aim of building an enhanced preparedness capacity in Palestine. HELP has a simple and flexible but very effective logic to perform the early warning: **i.** Watch to open data sources on risk themes (NASA satellite data, Weather Forecast, world wide seismic networks, etc); **ii.** Apply (programmable) "intelligence" to detect critical situations, exceeding of thresholds, population potentially involved by events, etc; **iii.** Highlight critical elements on the map; **iv.** Send alerts to emergency managers.

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Keywords: Early Warning, Open Data,Web Processing Services, Geospatial, Spatial Data Infrastructures, Realtime, Web Dashboard

## INTRODUCTION

The Early Warning System is an Information Management Tool developed using geoSDI components to provide quick and intuitive visual evaluation of critical scenarios for alerts on Floods, Snow, Earthquakes and Drought. Risks or disasters are not events in our control, rather, they are situations to which we can better manage with a framework based on preparedness. The earlier and more precise the monitoring of hazards allow for faster response to manage and mitigate a disaster's impact on a society, economy and environment. This is exactly what HELP offers, it plays a main role in the cycle of early warning and risk (Preparedness, Risk, Mitigation, and Resilience). It provides information in real time on events and hazards, allowing for the possibility to analyze the situation and find a solution whose outcome protects the most lives and has the least economic impact. There are many open source geographic data and monitoring systems services. Combining these information and applying elaboration algorithms trigger Web Processing Services, is the key used by this system for effective early warning actions.

## THE GENERAL APPROACH: FLEXIBILITY

The Early Warning System is an Information Management Tool to be developed using geoSDI components to provide quick and intuitive visual evaluation of critical scenarios for alerts on Floods, Snow, Earthquakes and Drought. In other words, the EW System is supposed to give decision makers a very quick and early view on a potential emergency that will be managed. So as to activate, all the Actions of the Emergency Response, once the effectiveness of the warning is evaluated. To be effective in reaching this purpose, the system applies a very simple and flexible approach: connecting to available open data streams, processing the source, and generating the alert. Finally, a web dashboard is used for the visual representation of the critical situations, for historical analysis and forecast evaluations. Every single element of this chain is treated in the following sections.

### Information Crawling

A specific module to provide the services required to implement the early warning system was built. Real time event on earthquake, fires, droughts and rainfall are examples of real time events. To complete the scenario, Some RSS news channel are used to get the actual situation in the area of interest. The server part of the system is designed to be as flexible as possible: it allows you to connect to third party monitoring services in order to include various types of events. On the other hand, the module exposes APIs that allows customers to subscribe to a list of early warning, linked to a particular type of event (Early Warning Channel). This server Component is responsible to:

- Scan the configured sources/services (Early Warning Source) Check if a risk event occurred
- Store the event details into an Internal Database (ElasticSearch based)
- Expose a REST API to get the event details
- Do some processing to determine combined effects, like for example:

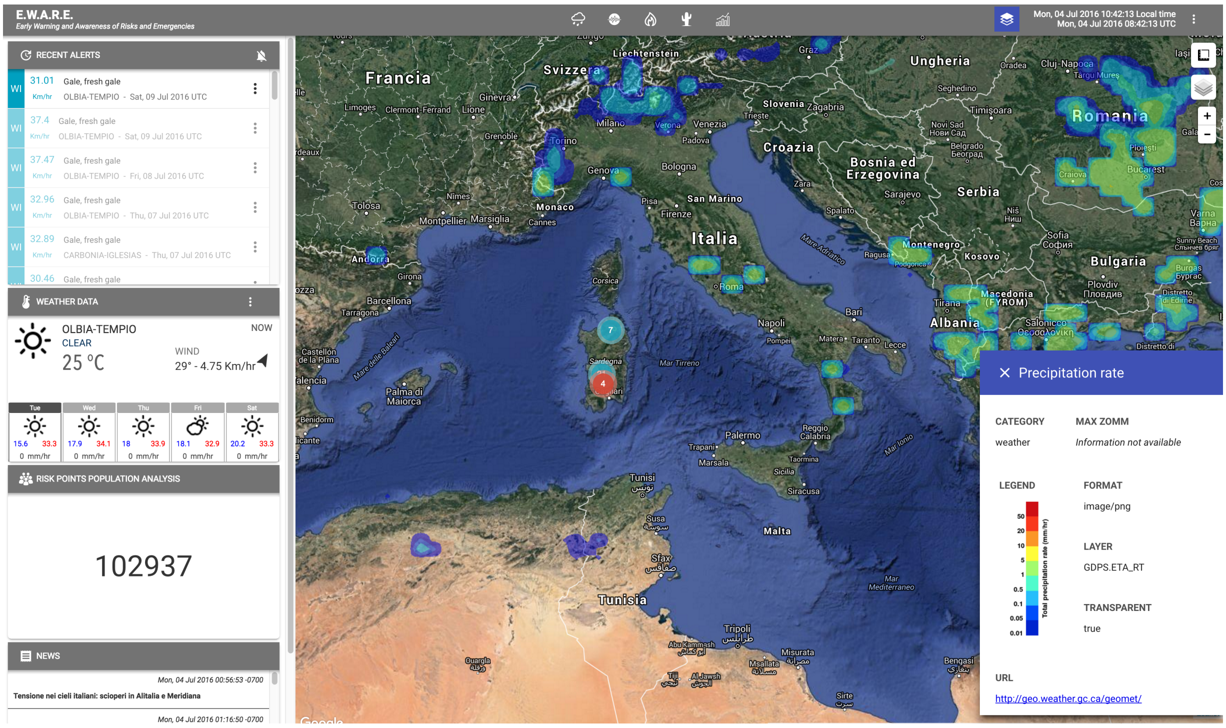


**Figure 1.** A view of the HELP Early Warning Dashboard.

- estimation of population involved with reference to Population Data and Risk / Exposition / Vulnerability Data

- Send an Email Alert to a configured list of users, including Basic information about the event and a link to the Early Warning Web Dashboard (on the event). (Details on EW Web Dashboard later in the doc)

- Prepare and serve the package of all the information related to an Early Warning Event. This package of information is displayed by the Early Warning Web Dashboard.

In more details, the modules in Figure 2 do the following jobs:

- **Service Scanner Module.** Has the logic to connect a EW Source, get the event in the available format and store it into ElasticSearch Store. For each EW Source, the logic has to be defined. When an event triggers a warning situation, it passes parameters to the EW Processor module to compute the alerting information.

- **ElasticSearch Store and API Module .** Collects the events object in its text-oriented storage; Exposes REST API to get events and details; This module allows you to normalize access to information, regardless of the format returned from the EW-Source. It also stores the side information of an EW object calculated by the processor module when an event triggers a warning scenario. Elasticsearch automatically distributes shards of an index over all nodes in

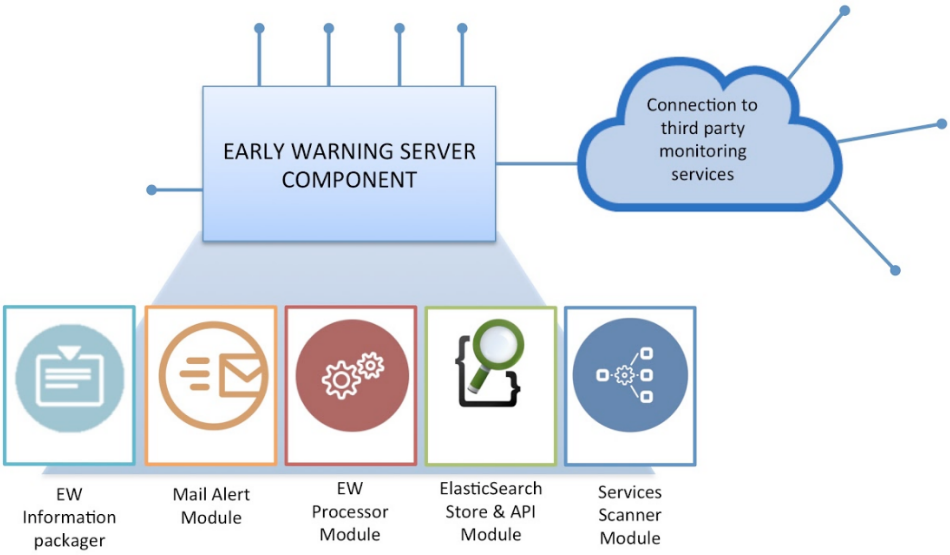


**Figure 2.** The Server Componets of the HELP EW System.

a cluster and controls that are loaded equally. Since it is expected that this type of systems handle growing big-data with variable patterns, Elasticsearch is a better choice than using relational database, as it scaled horizontally.

- **EW Processor Module.** Has the logic to evaluate the event information in relation to Population Data and Risk Data and to decide if an EW message has to be fired. Once the process has been executed, it stores information calculated in the Elasticsearch module.

- **Mail Alert Module.** Has the logic for packaging the alert and for sending the Mail Alert, containing the link to the Web Dashboard with specific parameters of the event that generated the warning.

- **EW Information Packager Module.** This module (physically implemented through Elasticsearch APIs) is the server bridge between the Web Dashboard and the collected information. The web interface calls this module to get the event information and side information, without executing the processes any time.

In the last Section of the document, you can find a list of the major Early Warning Sources configured.

**Logical Processing**

When should it generate a warning? Is it sufficient for a natural event to occur to trigger a warning? When an event occurs, an early warning should be reported when the event can cause damage to persons and / or infrastructure. Only the position and "size" of the event is not sufficient to tell whether a warning should be generated or not. This is why additional data source on Population, on Infrastructures and on points historically affected by similar events are crucial and included.

***The processing approach***

It was considered important to think of a flexible and transparent approach:

- A condition acts as a trigger
- The event detail are crossed with Population Data, Infrastructures and points historically affected by similar events
- The process extracts the potentially affected population and potentially affected points (buildings, infrastructures, etc)

The process approach (whatever the risk type) is independent from the resolution. The accuracy of the extracted data is not. But just because the process is independent, population data and risk can be updated and improved over time, resulting in more accurate information extracted.

**An example of processing performed:** *When the rainfall forecast in the area of interest is in a specific configured range of rainrate, intersect the layer of risk zones and highlight the geometry of the intersected ones; intersect the historical risk point and highlight the interested ones; intersect the population density layer and compute the potentially involved number of people; store all this information assigning an alert ID; send an email to the configured mailing list with the link of the Dashboard, having the alert ID as parameter to center the map and to load the related scenario.*

**Alerts Dispatching**

Configuration Interface was built for allowing to define different parameter for the different Risk Theme. For example you can determine the minimum magnitude of an earthquake that will fire an alert, or rainfall ranges of precipitations, wind thresholds and so on. Also the list of email addresses to be alerted and the area of interest (Bounding Box) can be configured. A user list can receive a message when it happens a sequence of events. In fact, if a critical situation (corresponding to the configuration criteria) is detected (ex. an earthquake happens and has a magnitude greater than a certain parameter, or rainfall related risk and so on) then a list of users will receive an email. The email template contains the alert general information (type, location, “size”) and a link to the HELP Dashboard that allows the receivers to instantly see the scenario of the selected event. The email module acts not only when a critical event happens, but also with a period: for example a list of events can be sent periodically at set times, so the managers can get a picture (eg every day, week, etc ..) of the events and related situation that occurred.

**The Dashboard**

The system is based on the simultaneous management of multiple data streams. A top left panel loads the recent alerts. A menu allows you to filter selecting a specific theme (Earthquake, Weather, Fires, Droughts). Selecting an item from the list, the dashboard loads on the map the related information, like the position of the alert, the weather conditions in that location, the potentially involved population inside three buffers, Rss News related to the interested area.

Each stream interacts with other flows following the rules and logic that are defined in the processing logic. The sequence in which the connections between the flows are performed creates a waterfall effect. Thus a cascading effect provides immediate view of what happens when an Event occurs. Of course you can overlap other WMS layers to the map to perform your evaluations. Other

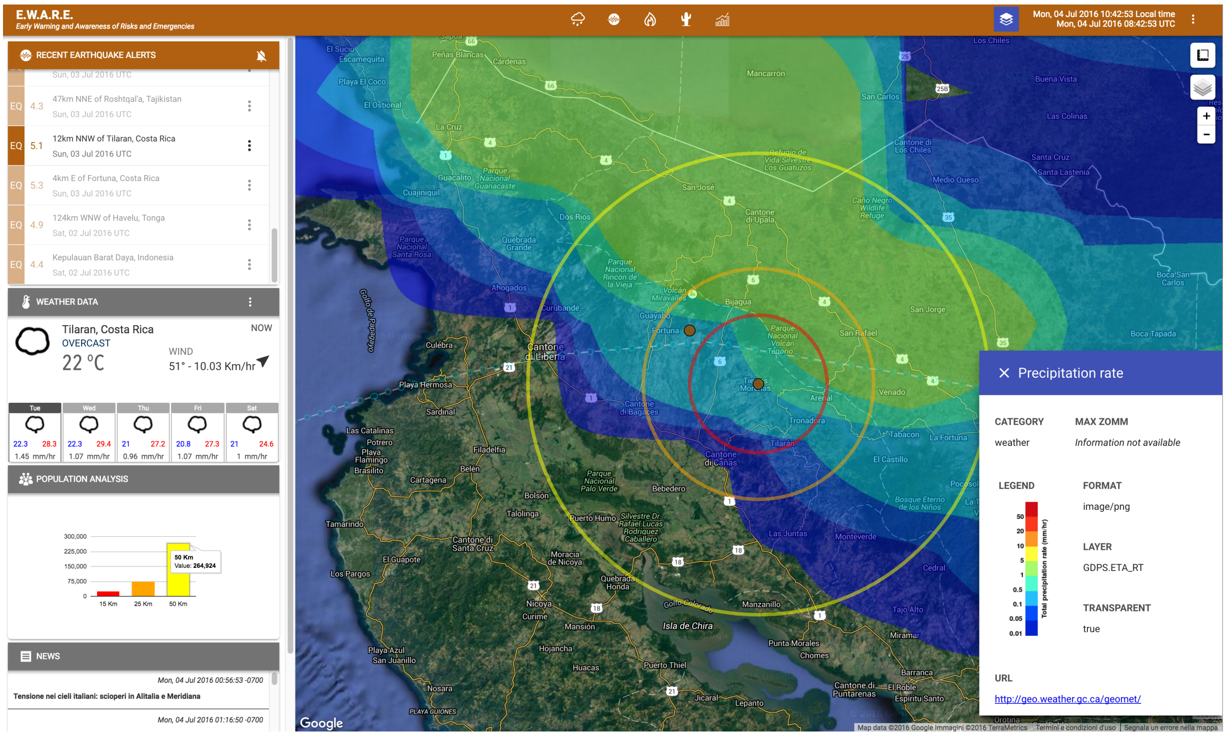


**Figure 3.** A view of the Dashboard focused on the Earthquake Theme.

screens can be used to consult forecasts or historical data on the selected themes or selected Critical Event. For each event the authenticated user can also upload documents and files, enriching the description

## OPEN DATA AND OPEN TECHNOLOGIES USED

One of the strengths of the system is to use open source. This allows you to leverage data from specific monitoring systems and combine them together to assess meaningful situations. the technologies used are also open, thus promoting the possibilities of growth and the construction of new facilities. Although all the technologies used are open source, the source code of the product is currently maintained on a private repository GitLab. In the near future there will be an optimization of the source code and the publication of the project on GitHub, fully open source and open to collaborations.

### *Data Sources*

Any third party source/service for triggering an Early Warning Alert has been called Early Warning Source (EW Source). For each EW-Source are to be defined:

- Entry point of the EW-Source
- Returned Format
- Method / Processing to fire for generating the Alert

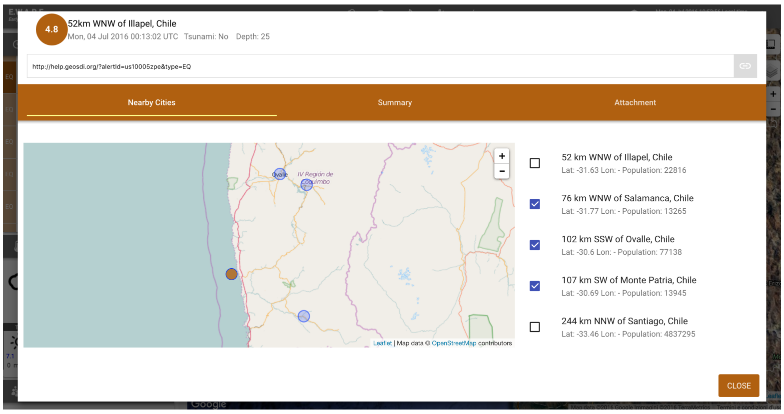


**Figure 4.** Example of details about a Seismic event.

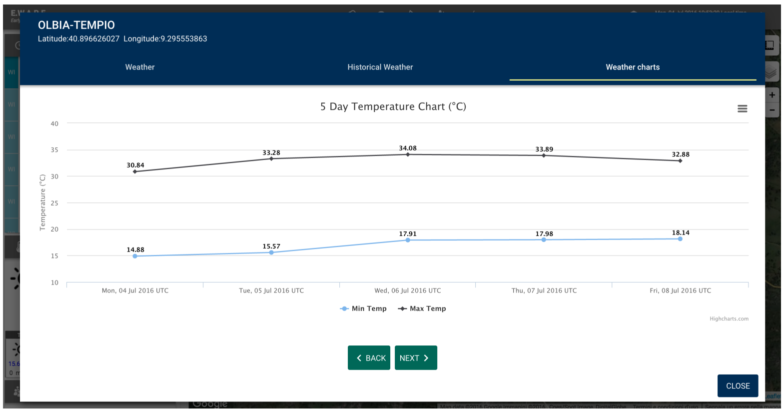


**Figure 5.** Example of charts on weather forecast.

The EW Sources used in this prototype are the following:

**Earthquake Theme:** U.S. Geological Survey. The USGS Earthquake Hazards Program is part of the National Earthquake Hazards Reduction Program (NEHRP), established by Congress in 1977. It monitors and reports earthquakes, assesses earthquake impacts and hazards, and researches the causes and effects of earthquakes. An example of the service used is: 1*.

**Weather Theme:** provide accurate short -term and long-term weather predictions. The Forecast API allows you to look up the weather anywhere on the globe, returning (where available): Current conditions; Minute-by-minute forecasts out to 1 hour; Hour-by-hour forecasts out to 48 hours; Day-by-day forecasts out to 7 days. An example of the service used is: 2*.

**Fires and Drought Themes:** NASA Global Imagery Browse Services (GIBS). GIBS provides quick access to almost 200 satellite imagery products, covering every part of the world. Most imagery is available with a few hours after satellite overpass and some products span over 15 years. For fires Fire Information for Resource Management System (FIRMS) is used https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data . Many NASA GIBs layers are also included as overlap options

***Involved Technologies***

- **Services Scan, WPS execution, Alert dispatch:** Geo-Platform Framework by geoSDI - Java based.
- **Information Storage and data access API:** Elasticsearch
- **EW Dashboard:** Google Polymer Framework
- **Software repository:** Private instance of GitLab

## CONCLUSIONS AND PERSPECTIVES

The experience carried out with this prototype shows that Elasticsearch is an easily scalable, full-text search engine that is capable of handling large amounts of online and schema-less data. This really is an interesting possibility for scientific projects and operational applications, because of the different types of data can be handled better and with excellent performance over traditional relational databases. The use of Elasticsearch jointly with established technologies, such Google Polymer and Geo-Platform Framework, opens the possibility to quickly build the monitoring and analysis dashboards, which can easily be connected to different sources of information, both based on observational technologies by satellite , and based on networks of sensors on the ground. Further investigations and experiments will also be conducted to evaluate the integration of information from socialnetworks and the correlation with observed events from sensor networks, in order to improve the early warning systems also according to the social dynamics as well as on the basis of the Earth Observation. An optimization of the source code and the publication of the project on GitHub, fully open source and open to collaborations, is another important future step, that will enable scientific and technical contributions.



1* http://earthquake.usgs.gov/fdsnws/event/1/application.json

2* https://api.forecast.io/forecast/APIKEY/LATITUDE,LONGITUDE

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