Dewetra, Coping with Emergencies

Paola Pagliara
Department of Civil Protection, Rome, Italy
paola.pagliara@protezionecivile.it

Angela Corina
Department of Civil Protection, Rome, Italy
angela.corina@protezionecivile.it

Alessandro Burastero
ACROTEC, Savona, Italy
alessandro@acrotec.it

Paolo Campanella
FadeOut Software, Genoa, Italy
p.campanella@fadeout.biz

Luca Ferraris
CIMA Research Foundation, Savona, Italy
luca.ferraris@cimafoundation.org

Marina Morando
CIMA Research Foundation, Savona, Italy
marina.morando@cimafoundation.org

Nicola Rebora
CIMA Research Foundation, Savona, Italy
nicola.rebora@cimafoundation.org

Cosimo Versace
ACROTEC, Savona, Italy
cosimo@acrotec.it

ABSTRACT

Dealing with multi-risk assessment needs reliable forecasting and warning systems able both to rapidly make available observational data and to make accessible forecast tools to the Decision Makers. In this paper we present Dewetra, a real-time integrated system for risk forecasting, monitoring and prevention. We provide a description of its features and examples of its operational use at the Italian Prime Minister Office - National Department for Civil Protection- Centro Funzionale Centrale. In particular is presented its application to flood risk management and to wild fire risk management.

Keywords

Risk assessment, emergency management, early warning system.

INTRODUCTION

Establishing a viable forecasting and warning system for Communities at risk requires the combination of data, forecast tools, and trained forecasters. These ingredients must be contained in each Operation Centre for civil protection which should be able to issue warnings by itself, while the centres should be connected into a network that exchange data, procedures, models and expertise.

The effectiveness of such a scheme relies on the rapid availability of data, so that the forecast system can produce up-to-date and reliable forecasts. Coordination and data sharing can significantly increase the amount of data available. In this context, it is of valuable importance to acquire the whole information observed by the different available sources. Data should refer to different space and time scales They have different levels of uncertainty and reliability. Dewetra uses a hybrid architecture which combines a client/server middleware to ensure robustness and data local back-up, with a web-based application to ensure capillary distribution of information.

Hydrometeorological data and accurate forecasts are of no value if the forecasts do not reach users and if decisions are not made as to the suitable actions required. Results of flood or forest fire prediction models must be disseminated so that decisions can be made and actions taken to reduce the impact of the pending event. Decision support encompasses all the actors of emergency cycle, spanning from forecasts reaching decision makers such as the Mayor of a flood-prone community to the operator of a flood-control structure. For decision

Reviewing Statement: This short paper has been fully double-blind peer reviewed for clarity, relevance and significance.

support to be effective, advanced planning must define prescribed actions linked to forecasted values.

BUILDING A RELIABLE RISK SCENARIO

Dewetra is a real-time integrated system for risk forecasting, monitoring and prevention. Dewetra is owned by and fully operational at the *Italian Prime Minister Office - National Department for Civil Protection- Centro Funzionale Centrale*. The system is technically and operationally certified. The system has been designed by CIMA Research Foundation on behalf of Italian Civil Protection with the task of developing a flexible and robust tool to support the operational activities of Civil Protection in Italy and abroad for International Cooperation initiatives.

Dewetra hardware and software architecture is fully compliant with the requirement of a flexible Decision Support System, which through a multi-layer Graphical User Interface (GUI) can provide decision makers with high resolution and rapid refresh information of the expected and observed risk. The application is published on a Web Server. The access is via internet using the standard http protocol. Through the web server the user has access to remote web services. The main component of the application is a map. The layer is presently provided by the Google® server. Other layers published by the Geo Server as Web Map Service (WMS) can be used as background layers.

Figure 1 Dewetra has five control areas, which define the main functionalities of the system (see A, B , C , D, E in the figure). A - the Google Maps® engine; B - the main upper toolbar contains the groups of information layers and the functionalities available; C - the navigation tree containing dynamic and static layer; D - a set of navigation tools; E - time range and scales for the representation of data.

Dewetra has five control areas, which define the main functionalities of the system (see A, B , C , D, E in Figure 1).

A: the Google Maps® engine embedded in Dewetra provides the official worldwide toponym considered by Google® along with the locations of the whole Meteorological Station network used by DPC.

B: the main upper toolbar contains the groups of information layers and the functionalities available in Dewetra. (Background layers, Dynamic layers, Weather Stations Network, Navigation tools, WMS query, and Measuring tools).

C: the navigation tree appears on the left side of the Dewetra window. The tree root nodes correspond to the dynamic layers in the top pane of Dewetra window. When a plus sign (+) appears before a node, the user can expand the node to view the legend belonging to the node.The available layers structure comprises the active

layers, along with the "static" off-line layers loaded on the Geo-Server (ancillary data, risk assessment, elements at risk).

D: a set of navigation tools allows users displaying information and maps at different scales (zoom) navigating on the maps using the pan command.

E: the time range of the data visualised by Dewetra allows selecting and navigating through the time scale used for the representation of the data. The user can select a time window from specific date in the past time until now, up to 72 hours from the last run of the system in the future time.

WEATHER OBSERVATIONS

With Dewetra users manage and display up to date information both of dynamic and static (off-line) nature. Such data can be conveniently used to track significant weather events, build detailed risk scenarios and, eventually, to evaluate the potential impacts of expected/observed events on Communities and Infrastructures.

Dewetra provides Civil Protection users with Near Real Time (NRT) weather information through the networks of Remote Automated Weather Stations (RAWS Figure 2) managed by the meteo-office of the Italian Regions and the national RADAR network. There are nearly 2000 Regional RAWS strategically located throughout Italy.

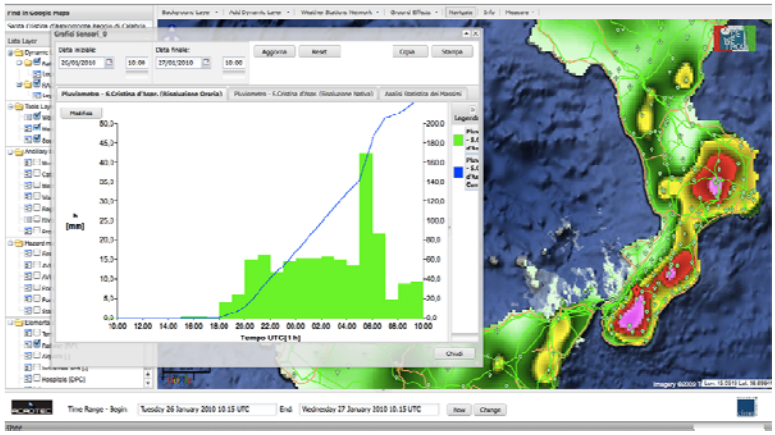

Figure 2 NRT RADAR data along with observed rainfall provide Civil Protection with reliable information on ongoing events

These stations monitor the weather and provide weather data that assists land management agencies with a variety of scopes such as monitoring rainfall, temperature, rating fire danger, and providing information for research applications. Using the data observed by the RAWS, Dewetra provide users with NRT fields of temperature and rainfall, as well as aggregated rainfall fields defined upon different time intervals.

RISK ASSESSMENT

Dewetra is part of the early warning system for natural risks put in place by the *Italian Prime Minister Office - National Department for Civil Protection- Centro Funzionale Centrale* and called *Sistema dei Centri Funzionali (System of Operation Centres)*. The system work as a network where the Operation Centres for civil protection, at regional level, are connected into a network that exchange data, procedures, models and expertise. Each should be able to issue warnings by itself based on a common set of data, models and information shared also through Dewetra. Dewetra is thus the part of the system devoted to risk forecasting, monitoring and prevention. Due to the wide scale of the phenomena and their high frequency in space and time wildfire and flood risk assessment and forecasting have been selected as priority applications in Dewetra. Its structure allows however for a quick integration of models and monitoring systems devoted to risks such as landslides, droughts, heat waves, chemical and hazardous materials transportation.

In case of wildfire, Dewetra provides daily risk indexes, obtained from the aggregation in time and space of the risk values; along with the hourly dynamics and the spatial representation of the variables and the parameters

(observed and forecasted) used to represent the risk (RISICO model, Fiorucci et al., 2008). A specific stochastic wildfire propagator model, based on a cellular automata approach, completes the wildfire risk assessment in Dewetra. The propagator allows users simulating wildfires simply inserting on the Google® map the ignition point of the fire and the wind speed and direction. This will result on fire spread scenarios.

In case of flood risk, Dewetra is able to provide flood forecasts based on modelling tools developed by CIMA Research Foundation such as Flood-PROOFS (Flood-PRObabilistic Operational Forecasting System), an early warning system designed for operative flash floods forecasting in small and medium catchments (Siccardi et al., 2005) The architecture of Flood-PROOFS is composed of standardized units. These can be assembled in multiple ways to fulfill the requirements of the end user. The algorithms implemented in Flood-PROOFS are able to model in a distributed manner the physical phenomena which lead to the formation of flood events. Different modules simulate the various hydrometeorological phenomena such as: fine scale precipitation intermittency, separation between solid and liquid precipitation, dynamics of snow cover, runoff and hypodermic flow processes. In particular the downscaling of forecasted precipitation statistically allows the description of the fine-scale structure that it is not fully described by meteorological models (Rebora et al., 2006). The hydrological modules describe and evaluate, in terms of run-off volumes and flow in drainage network, direct effects on the soil (Giannoni et al., 2005; Gabellani et al., 2008). The system is able to use as input Quantitative Precipitation Forecast (QPF) derived from Limited Area meteorological Models (deterministic run or Ensemble suite) as well as prediction issued by expert forecasters. Starting from the available QPF, the main outputs produced by the computational chain are both a probabilistic and deterministic discharge forecasts in a defined number of outlet sections of the considered catchments.

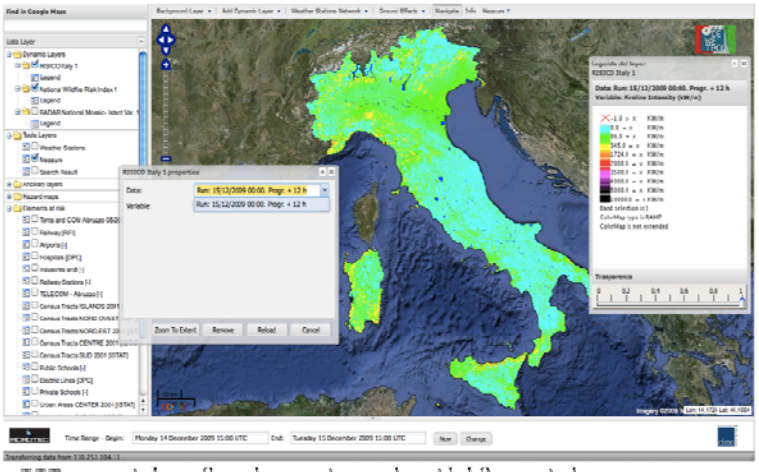

Figure 3 HR rapid refresh national wildfire risk assessment and forecasting.

EMERGENCY MANAGEMENT

According to user requirements and infrastructure it enables embedding of various kinds of information related to risk (e.g. hazard maps, NRT weather data, EO data, further ancillary and user data, land cover information).The integration of all information relevant for risk management supports the decision makers. During the preventive phase, Dewetra shall provide Decision Makers with a quantitative detailed evaluation of the effects of the main atmospheric variables, along with the expected risk over the considered area and highlighting the zones denoted by the highest risk values. In the preparedness and response phases, Dewetra can be conveniently deployed to forecast the dynamics of the expected events, taking into the whole risk scenario defined by the kind and the value of element at risk exposed to the effects of the considered variables (Figure 4).

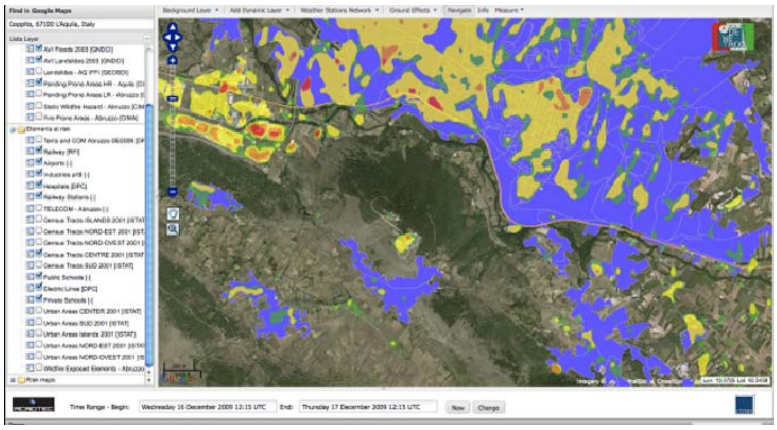

Figure 4 ***Ancillary data, static risk maps and NRT information are used to produce detailed Risk scenario.***

CONCLUSIONS

Dewetra is a system that provides Civil Protection with an integrated approach to assess and forecast the risk over wide areas for a significative time horizon (up to 72 hours) basing on a up to date and complete information set. The system can help decision makers for resource management and planning, suggesting the tactical deployment of the available squads and the adoption of some restrictive measures or limitations. Even more important, the broadcasting of alert messages to emergency services may strengthen the effectiveness and the promptness of the response. No specific skills are required for the proficient use of Dewetra service/products. However, basic skills in GIS and some knowledge of physical meaning of the information provided by the Dewetra are required for a correct use of the system.

REFERENCES

1. Fiorucci P., Gaetani F., Minciardi R. (2008) - Development and application of a system for dynamic wildfire risk assessment in Italy. *Environmental Modelling &Software*, 23, 6, 690-702.
2. Gabellani, S., Silvestro F., Rudari R., Boni G. (2008) - General calibration methodology for a combined Horton-SCSinfiltration scheme in flash flood modeling, *Nat. Hazards Earth Syst. Sci*., 8, 1317–1327.
3. Giannoni, F., Roth, G., and Rudari, R.(2005) - A procedure for drainage network identification from geomorphology and its application to the prediction of the hydrologic response, *Adv.Water Resour*., 28(6), 567–581.
4. Rebora, N., Ferraris, L., Hardenberg, J. H. Provenzale A (2006) - The RainFARM: Rainfall Downscaling by a Filtered Auto Regressive Model. *Journal of Hydrometeorology*. Vol 7(4), 724--738.
5. Siccardi, F., Boni, G., Ferraris, L, Rudari R.(2005) - A hydro-meteorological approach for probabilistic flood forecast. *Journal of Geophysical Research*, Vol 110, d05101, doi:10.1029/2004jd005314, 2005.