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Stochastic forecasts and extreme weather events. The case study of intense and devastating rains over NW Greece during the period 30 Jan-1Feb 2015

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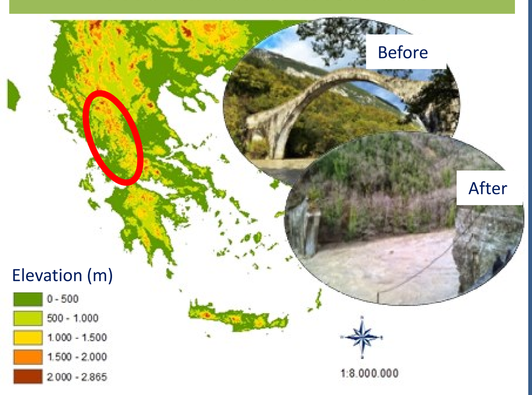
Introduction

In 2015 and during the January 30 to February 1 period, the extended territory of Arta (NW Greece) experienced intense and devastating rains which caused huge disasters. But nor floods or landslides or crop damage or evacuations of villages caused so much anger and sadness as much as the collapse of the historic bridge of Plaka in Tzoumerka Mountains.

Map of Greece
The area of interest

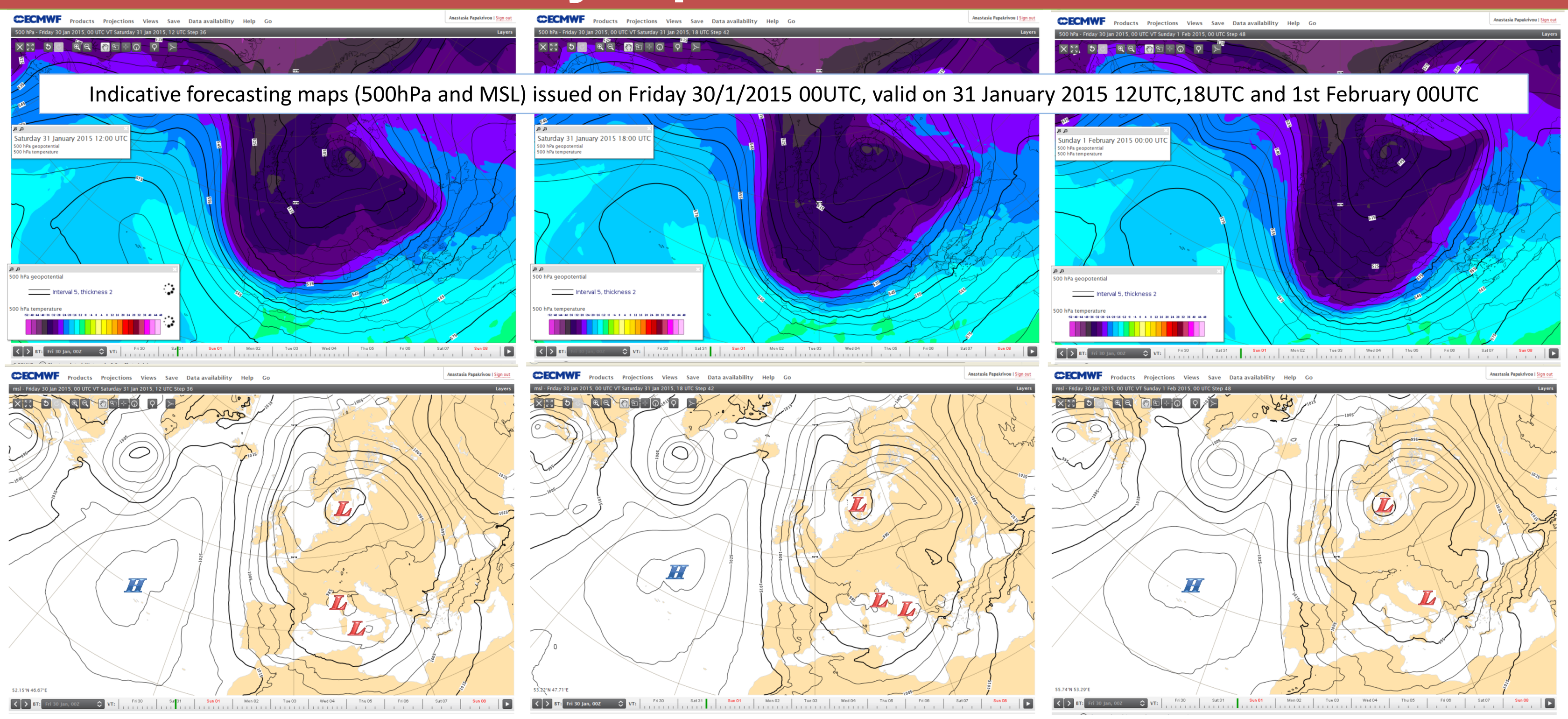


Nowadays there is a profound increase in the number of natural disasters attributed to extreme weather events (WMO, 2013) which is significantly impeding progress towards sustainable development (UN,2015). The most common approach for the classification of an impending weather event as "probably extreme", presupposes that at least one of its defining meteorological parameters is expected to exceed some predefined thresholds. These thresholds are relative to the region of occurrence, and thus its climate, rendering this a purely meteorological topic.

As however, the severity of the impacts of extreme weather events depends strongly on the level of vulnerability and exposure of the local societies to these events (IPCC,2011), it is the decision makers who, except the meteorologists, also need to take action and properly manage and exploit meteorological information. Thus, taking into account the social, economic and other constraints decision makers are called to act in, except of being accurate in space and time predictions, forecasts need to give further, quantitative information concerning the risk level of an impending weather event. Such a forecast, presented in an appropriate way leading to a clear interpretation, would be an extremely useful tool, particularly in the phase of preparedness (IPCC,2011-Bazza,2013). In this paper, we test the effectiveness of the ECMWF stochastic weather forecasts and demonstrate their utility in decision-making, under the supervision of an experienced weather forecaster. To do so, we use as case study the region of Arta in northwest Greece, which experienced intense and devastating rains during the period January 30 - February 1 2015.

Synoptic situation

Indicative forecasting maps (500hPa and MSL) issued on Friday 30/1/2015 00UTC, valid on 31 January 2015 12UTC,18UTC and 1st February 00UTC

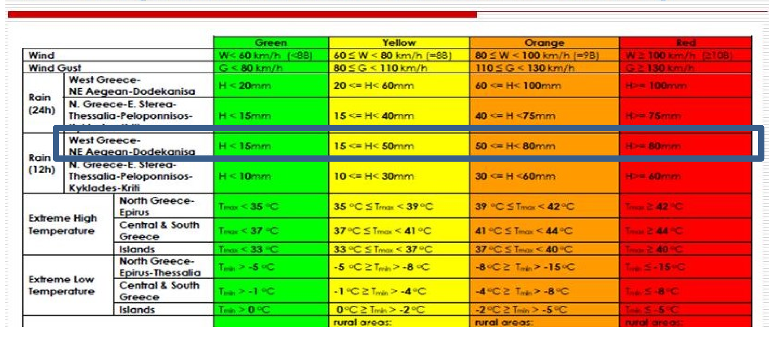


In the upper atmosphere (500hPa), the strong northerly airflow over Western Europe, caused by an extensive low centered in northern Europe, feeds western Mediterranean Sea with cold air mass, which, enriched with moisture, move over Greece due to the strong southwest flow over central and eastern Mediterranean Sea. At the surface (MSLP), a deepening low pressure centre over northwest Greece on the evening of January 31.

Probabilistic approach

meteoalarm alerting europe for extreme weather — a joint initiative of the Members of EUMETNET The Network of European Meteorological Services — to alert Europe for extreme weather

Greece (Different areas – Different thresholds)



The thresholds used in the case study are the meteoalarm thresholds defined by the Hellenic National Meteorological Service.

According to the meteoalarm color code, "orange" for West Greece means that the 12hr accumulated precipitation is expected to exceed 50 mm. This is why charts illustrating the probability of the 12hr accumulated precipitation to exceed 50mm, are thought to be a useful tool in the phase of preparedness. In addition, considering an apparent increase of the region vulnerability, due to the significant rainfall observed during the previous days, we decided the parallel use of charts with the probability of the 12hr accumulated precipitation to exceed 30mm, a significant lower height. Using ecCharts, we synthesized forecasting maps showing the probability of the 12hr accumulated precipitation to exceed the defined thresholds (three runs: 30/01 00UTC, 30/01 12UTC, 31/01 00UTC).

These probabilities are showed in the Table below:

	P(%) > 30mm			P(%) > 50mm		
	Time before the event					
Forecast valid	36hr	24hr	12hr	36hr	24hr	12hr
31/1- 18UTC	35-65	65-95	100	0-35	0-35	0-35
31/1- 21UTC	65-95	100	100	35-65	0-35	35-65
1/2- 00UTC	100	100	100	35-65	35-65	65-95
1/2- 03UTC	100	100	100	65-95	65-95	100
1/2- 06UTC	100	100	100	35-65	35-65	65-95
1/2- 09UTC	65-95	100	100	35-65	35-65	35-65
1/2- 12UTC	65-95	65-95	65-95	0-35	0-35	0-35
run based on	30/00UTC	30/12UTC	31/00UTC	30/00UTC	30/12UTC	31/00UTC

e.g. Run 30/01 1200 UTC

65-95% chance the 12hr accumulated precipitation (31/01 06UTC - 31/01 18UTC) to exceed 30mm, in the region of interest.

0-35% chance the 12hr accumulated precipitation (31/01 06UTC - 31/01 18UTC) to exceed 50mm, in the region of interest.

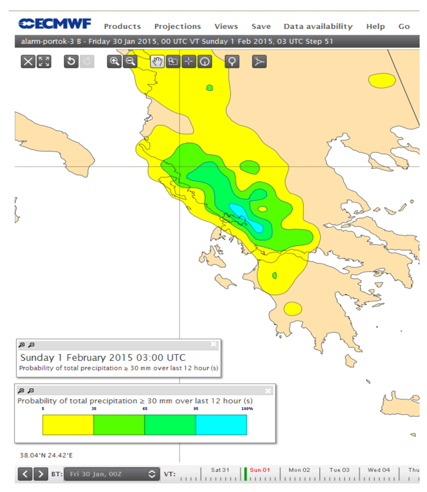
This information was operationally available about 24 hours before the event to be completed.

The crucial twelve hours: 31/1 15UTC – 01/02 03UTC

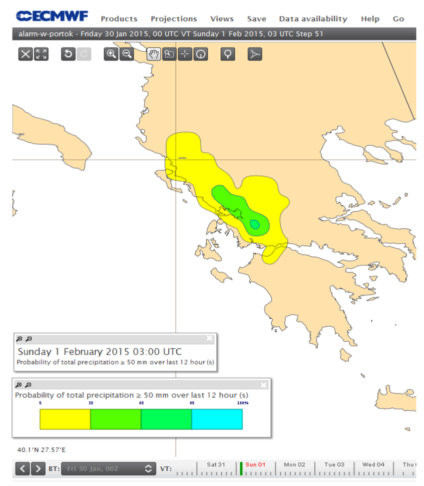
For this time period, the maps on the right show the spatial distribution of the probabilities for the three consecutive runs (30/00UTC-30/12UTC-31/00UTC). The following parameters are evident:

a. the spatial consistency
b. the certainty for exceeding the 30mm threshold, in all three runs, in the area of interest
c. the significant probability for exceeding the 50mm threshold in the first two runs turns to certainty in the last one

Run 30/00UTC Information operationally available about 36 hours before the event

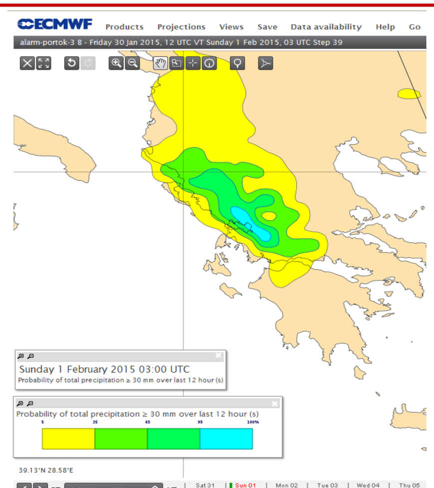


100% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 30mm, in the region of interest .

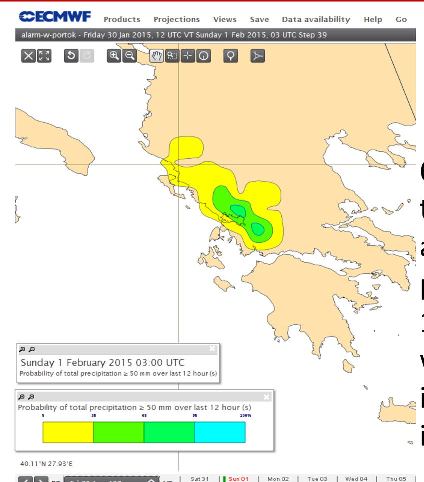


65-95% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 50mm, in the region of interest .

Run 30/12UTC Information operationally available about 24 hours before the event

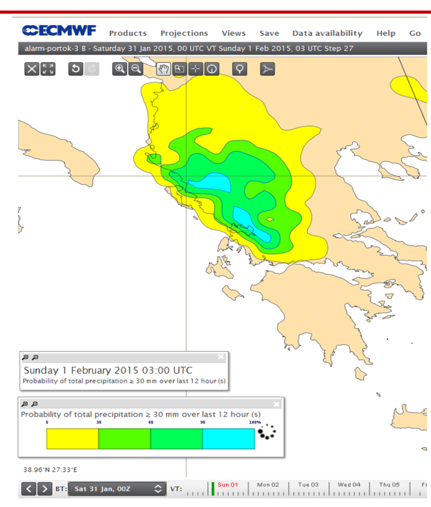


100% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 30mm, in the region of interest .

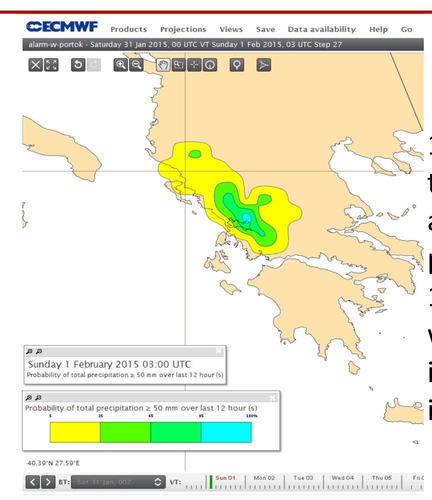


65-95% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 50mm, in the region of interest .

Run 31/00UTC Information operationally available about 12 hours before the event

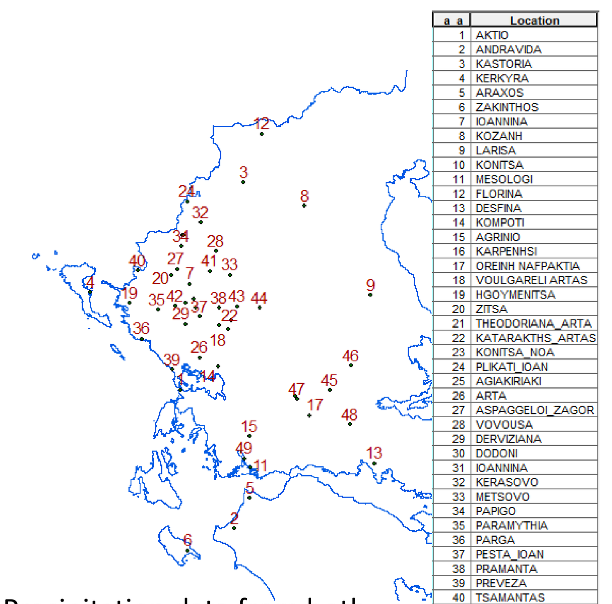


100% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 30mm, in the region of interest .



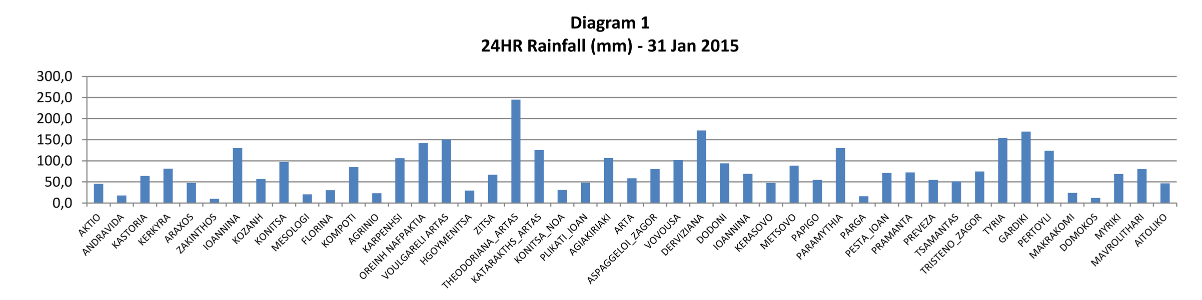
100% chance that the 12hr accumulated precipitation (31/1 15UTC-1/2 03UTC) will exceed 50mm, in the region of interest .

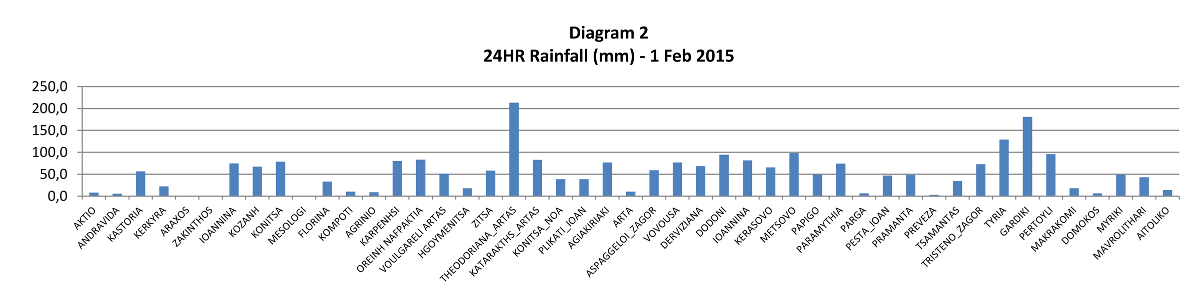
Evaluation - the spatiotemporal observed accumulated precipitation



Precipitation data from both, HNMS and NOA meteorological station networks, were used for evaluation purposes.

HNMS: Hellenic National Meteorological Service
NOA: National Observatory of Athens





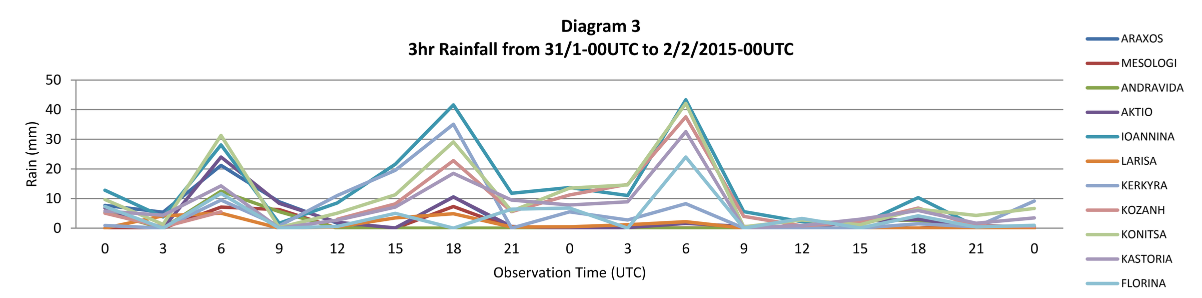


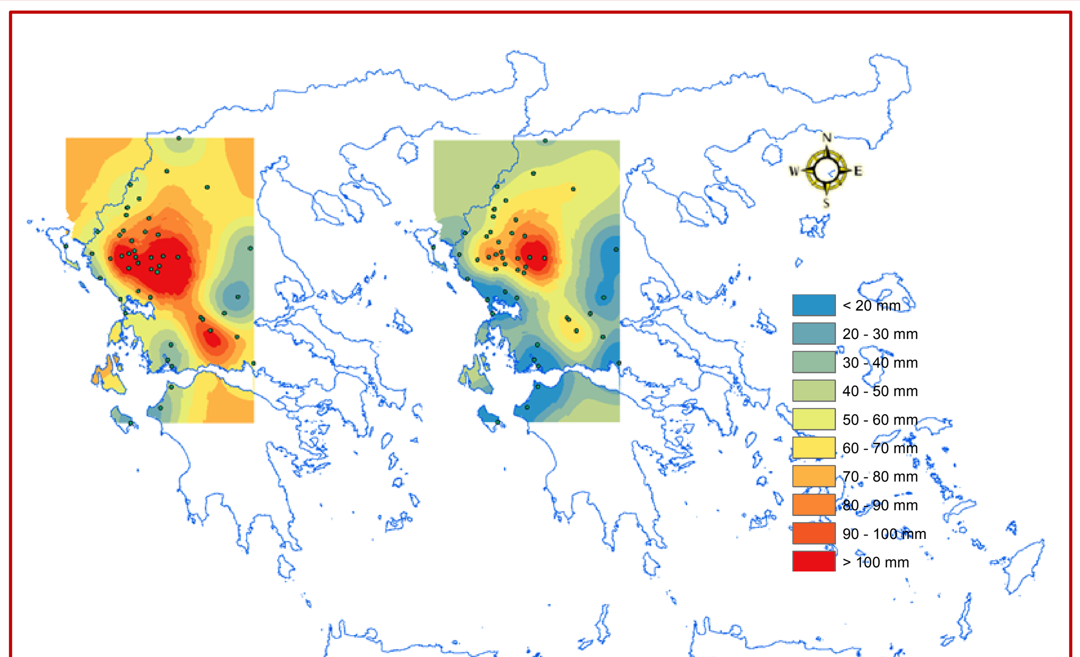
Diagram 1: the observed 24hr accumulated precipitation on January 31.

Diagram 2: the observed 24hr accumulated precipitation on February 1.

Diagram 3: two maximum of rainfall are confirmed:

a) in the evening of January 31 (18UTC), and
b) early in the morning on February 1 (06UTC).

More than 60% of the corresponding accumulated daily precipitation fell during the last twelve hours of the 31 January and the first twelve hours of February 1.



To graphically illustrate the areas that received the highest rainfall we attempted the spatial analysis and mapping of the 24hr precipitation on January 31 (on the left) and February 1 (on the right), by applying the method of Ordinary Kriging (ArcGIS).

Conclusions

- The predictive guidance on the probability of exceeding the predetermined thresholds is evaluated positively.
- The period of the exacerbation of the event was successfully determined.
- The spatial distribution of probability is assessed positively.

The use of stochastic (ensemble) forecasts is proved to be the necessary added value to the till now supplied meteorological information.
ecCharts, provides the ability for targeted analysis and synthesis of meteorological information and thus for tailor made products to fit operational needs and as a result to more effective management of natural disasters related to extreme weather events.

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