WSN12: Can you imagine an HAREN of Rainfall Nowcasts?

HAREN
Hazard Assessment based on Rainfall European Nowcasts

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after > 300 mm of accumulated rain
Why precipitation nowcasting is crucial in hydrology?

forecasting example using radar
(Besós river at Montcada, July 2001)

- observed runoff
- model
- model (without QPF)
- model (with radar based nowcasting)
Heavy Rainfall Warnings

Transportation

Hydrology

Sports

Outdoor Activities
Civil Protection Prevention & Preparedness Projects

Hazard Assessment based on Rainfall European Nowcasts (HAREN)
Objective

Heavy precipitation is one of the agents leading to major natural hazards in EU

THE CHALLENGE

Forecast the precipitation field at very high-resolution to produce better warnings for hazards induced by precipitation

Using the EU continental precipitation maps generated from the National radar networks provided by OPERA
From observations

Warnings at sensitive points

HAREN

High resolution rainfall nowcastings over Europe @2km every 15 minutes

Disseminate them
BASIC PRODUCT:

A radar-based rainfall nowcasting at European Scale
Radar-based rainfall nowcasting using OPERA European composites

OPERA radar mosaic:
precipitation observations over Europe @2 km and every 15 minutes.
Radar based rainfall nowcasts
Nowcasts @ 27 October 2011 04:45 UTC up to 6 h
Basic Rainfall Nowcasting based on OPERA COMPOSITES

- Already operational inside the project
- OPERATIONAL at the EU Civil Protection Emergency Monitoring Center (MIC) in OCTOBER 2012
- Verification by the associated stakeholders during next 9 months
ADVANCED PRODUCT: Probabilistic Nowcasting

Can you imagine an HAREN of rainfall nowcasts?
Errors affecting radar-based nowcasting

Main sources of errors in Lagrangian Persistence forecasts

1) Errors affecting radar-based QPE (clutter, VPR, Z-R, ...).

2) Estimation and evolution of the motion field

3) Growth and decay (evolution of rainfall intensities)

(Courtesy of I. Zawadzki)

(1) Germann et al. (MWR2006)
Aim

Apply a **stochastic nowcasting technique** to describe the uncertainty in rainfall nowcasts through the generation of an **ensemble of radar-based forecasts**

Previous Radar observations

Ensemble of forecasts

Adapted to be used in **probabilistic rainfall-runoff modelling**
The technique - SBMcast(1)

An ensemble approach based on the hypotheses of the String of Beads(2) model for the evolution of the rainfall field:

- Simulation at 2 levels: global and pixel scale.
- Model for spatial and temporal correlation.
- Moving coordinates.

At present, implemented in Catalonia.
To be implemented at European scale during the project

(1) Berenguer et al. (J. of Hydrology 2011)
SBMcast

Global variables:

**WAR**: wet area ratio (% of the domain covered by rain)
**IMF**: image mean flux (average rainfall intensity over the domain)

19 July 2001

16 June 2009

**IMF**

**WAR**

solid line correspond to the variables measured over the observations.
SBMcast

Global variables: IMF*, WAR* modeled as a bivariate AR(5) process:

\[
\begin{align*}
\begin{bmatrix}
WAR^*[t,n \cdot \Delta t] \\
IMF^*[t,n \cdot \Delta t]
\end{bmatrix} &= \sum_{i=1}^{5} \Phi_i \begin{bmatrix}
WAR^*[t,(n-1) \cdot \Delta t] \\
IMF^*[t,(n-1) \cdot \Delta t]
\end{bmatrix} + Z[t,n \cdot \Delta t]
\end{align*}
\]

Grey lines correspond to the variables forecasted (ensemble of 50 members)
SBMcast

Global variables: IMF*, WAR* modeled as a bivariate AR(5) process:

\[
\begin{align*}
WAR^*[t,n \cdot \Delta t] = & \sum_{i=1}^{5} \Phi_i \left[ WAR^*[t,(n-1) \cdot \Delta t] \right] \\
IMF^*[t,n \cdot \Delta t] = & \sum_{i=1}^{5} \Phi_i \left[ IMF^*[t,(n-1) \cdot \Delta t] \right] + Z[t,n \cdot \Delta t]
\end{align*}
\]

19 July 2001

16 June 2009

shaded areas correspond to the 10% and 90% percentiles for the 30 min forecasts
SBMcast

Global variables: IMF*, WAR* modeled as a bivariate AR(5) process:

\[
\begin{align*}
\begin{bmatrix}
\text{WAR}^* \left[ t, n \cdot \Delta t \right] \\
\text{IMF}^* \left[ t, n \cdot \Delta t \right]
\end{bmatrix}
&= \sum_{i=1}^{5} \Phi_i \begin{bmatrix}
\text{WAR}^* \left[ t, (n-1) \cdot \Delta t \right] \\
\text{IMF}^* \left[ t, (n-1) \cdot \Delta t \right]
\end{bmatrix} + Z \left[ t, n \cdot \Delta t \right]
\end{align*}
\]

19 July 2001

16 June 2009

shaded areas correspond to the 10% and 90% percentiles for the 30, 60 and 90 min forecasts
### Examples

<table>
<thead>
<tr>
<th>LP forecasts</th>
<th>SBMcast #1</th>
<th>SBMcast #2</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/07/2001 08:00:00</td>
<td></td>
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</tbody>
</table>

### CASE 1

![Map Image](image-url)
Uncertainty in LP nowcasts

SBMcast takes into account the uncertainty in LP nowcasts.

The goal is to improve SBMcast’s skill by driving the global variables WAR and IMF from NWP.

- NWP used to constraint the ensemble.
Uncertainty in LP nowcasts

SBMcast takes into account the uncertainty in LP nowcasts.

The goal is to **improve SBMcast’s skill by driving the global variables WAR and IMF from NWP.**

- NWP used to constraint the ensemble.
- Systematic factors such as the diurnal cycle of precipitation
ADVANCED PRODUCT: Probabilistic Warnings

Can you imagine an 
HAREN 
of associated warnings?

Based on the developments of
IMPRINTS
Probabilistic Early Warning System based on the probability of basin-aggregated rainfall exceedences

Guadalhorce basin (Malaga) 16/02/2010

Example of PFFGS 1 km
Source: CRAHI
Flood Warnings
2th Nov 2008
Catalonia
Integrated with the local Flood Hazard and Risk Maps (EU Flood Directive)
- Detailed information about flooded areas for different return periods
- Detailed information about critical points and impact of flooding
Basin warnings  10/10/2010
Dissemination at Civil Protection Level and through Meteoalarm
Precipitation is one of the agents leading to natural hazards that have very serious impacts on people's life and goods: i.e. floods, debris flows, landslides...

The challenge faced by this Project is monitoring and forecasting the precipitation field at very high-resolution to produce better warnings for hazards induced by precipitation at local scale all over Europe.

With this aim, the Project will focus on the use of the Continental precipitation maps generated from the National radar networks in Europe within the EUMETNET programme OPERA (Matthews et al. 2011). OPERA has succeeded in generating a European precipitation field in real time with the resolution of 20 km. The Project will use these maps to provide probabilistic ensemble nowcasting (e.g. Berenguer et al. 2011; Kolitschn et al. 2011).

The goal of the Project is thus to develop a system for precipitation monitoring and forecasting to be used in the anticipation of hazards induced by precipitation at local scale and over Europe. The Project will capitalize on the OPERA mosaics and on the recent improvements on nowcasting techniques, some of which developed and tested within several FP6 and FP7 EC projects (among others FLOODSITE, HYDRATE, and IMPRINTS (www.imprints-fp7.eu)), to generate high-resolution precipitation forecasts and warnings over Europe, as well as the associated uncertainty of these products.

www.haren-project.eu
Training course and Workshop:
Implementing the EU Flood directive in Flash Flood prone areas
Brussels 26 and 27 of September 2012

www.imprints-fp7.eu/finalworkshop