The Forecasters' Contribution to the Impact Assessment in Weather Warnings at the Royal Meteorological Institute of Belgium (RMIB)

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Foreword

At the last WGCEF meeting in Bergen, three issues were been presented concerning Belgium. Firstly, outputs from the short-term high-resolution ensemble GLAMEPS (0) were verified against the ECMWF and Aladin model outputs. Also, it was reported how efforts are made to contribute to severe weather management communications with media and Civil Protection through a federal Crisis Centre.

In this newsletter we discuss the third issue presented : the short range weather warnings issued by our forecasters.

Introduction

The severity level of weather warnings relies on a potential impact matrix which is illustrated here for some frequent weather events. The warning levels are determined by forecasters and produced using a colour and associated symbol(s). These warnings are issued in alignment with Meteoalarm objectives and criteria, using four colours to identify and describe the severity of the potential impact of weather events.

This potential impact estimated by forecasters depends both on specified quantitative and/or qualitative thresholds and on an evaluation of the risk to reach or exceed these thresholds. Some potential impact matrices built on thresholds (columns) and risk assessment (rows) are presented below.

For winds (gusts), snow/ice, freezing rain, and rainfall amounts associated to severe weather events, quantitative thresholds based on mean return periods have been defined.

For thunderstorm warnings the thresholds are mostly qualitative and the risk is evaluated using different tools such the probability scores derived using an interactive checklist focused on the potential for development of convective weather events. More details on the interactive checklist currently based only on one regional model (ETA) can be provided by the author on request. Furthermore other data are used like the analysis and forecasts of meteorological fields issued from numerical models. SAF Nowcasting products (cloud, precipitation and rapidly developing thunderstorm products), satellite images derived from RGB compositions (like the severe convection product), radar images and the lightning detection system (SAFIR) are mostly interpreted for nowcasting (very short range forecasts up to 1 or 3 hours ahead).

For cold spells and heatwaves, threshold values for surface temperatures (minima and maxima) and the number of consecutive days of an event are calculated to assess the potential impact. For heatwaves, the weather criteria along with an ozone concentration above a critical value are required to issue a red level warning in co-operation with the Ministry of Public Health.

All weather warnings issued by forecasters and reported here have a validity period of up to 48 hours ahead. They are forecast for the whole country and/or on a regional basis in accordance with nine Belgian provinces and a coastal area. For the Belgian maritime area only gale or storm warnings are currently issued.

Below we focus on the assessment of the potential impact for a selection of weather events forecast at short ranges. The methodology takes advantage of the meteorological expertise of forecasters using their analysis and their assessment of the most probable scenario. Furthermore a fine-tuning of the warning level(s) tends to take human and economic factors into account.

Example 1. WIND WARNINGS

The potential impact matrix below is based on gust forecasts. Columns show gust thresholds and rows the estimated risk levels. The icons with symbols and colours represent the potential impact level assessed by forecasters.

WINTER	< 80 km/h	80 – 100 km/h	100 – 130 km/h	≥ 130 km/h
> 90 %				
70 – 90 %				
50 – 70 %				
20 – 50 %				
< 20 %				

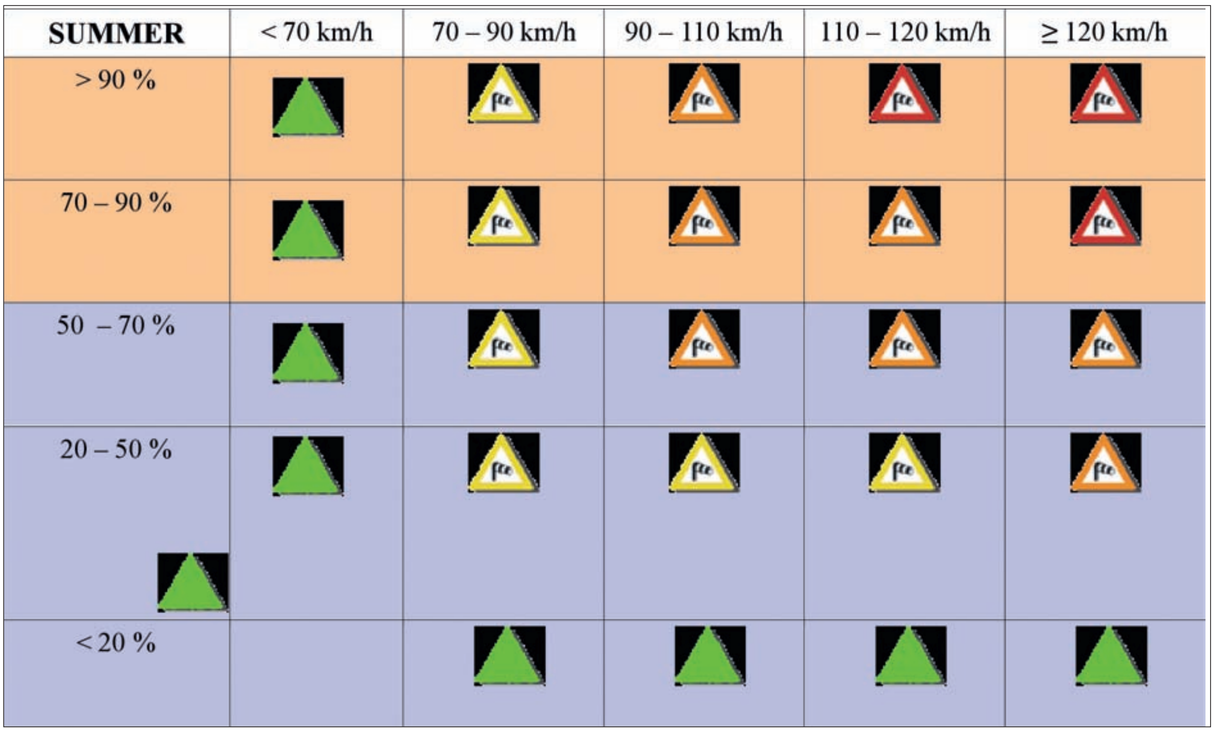
The risk level is evaluated as a complex function of several factors:

• Meteorological factors – the particular weather situation, the scale and location of the weather systems involved, and the effects of these factors on gusts. The gust forecasts are derived from several NWP deterministic models (a poor man's ensemble).

• Surface and soil factors - including surface roughness, soil moisture and vegetation type.

• Human and economic factors – including population density, economic sensitivity, time of day, week or year, traffic, or leisure activities.

The summer season is defined as when a large amount of trees are still in leaf. The thresholds are



SUMMER	< 70 km/h	70 – 90 km/h	90 – 110 km/h	110 – 120 km/h	≥ 120 km/h
> 90 %					
70 – 90 %					
50 – 70 %					
20 – 50 %					
< 20 %					

adjusted and there are five columns for the summer season. Otherwise the risk level is evaluated as in winter.

DECISION to forecast the potential IMPACT level

The potential impact level depends both on the forecast gusts reaching or exceeding the threshold values AND on the evaluation of the risk level. Different threshold values are provided in the two previous tables, respectively for the winter and summer seasons.

The impact level is then tuned by forecasters:

A/ the level is increased when

- the timing of the expected maximum gusts corresponds to peak hours (morning/late afternoon or early evening),
- the location corresponds to densely populated areas,
- people are unused to and unprepared for storm events in the location forecast,
- a long duration storm event is expected (eg due to successive troughs or frontal waves),
- the gusts are associated with unstable air.

B/ the level is decreased when

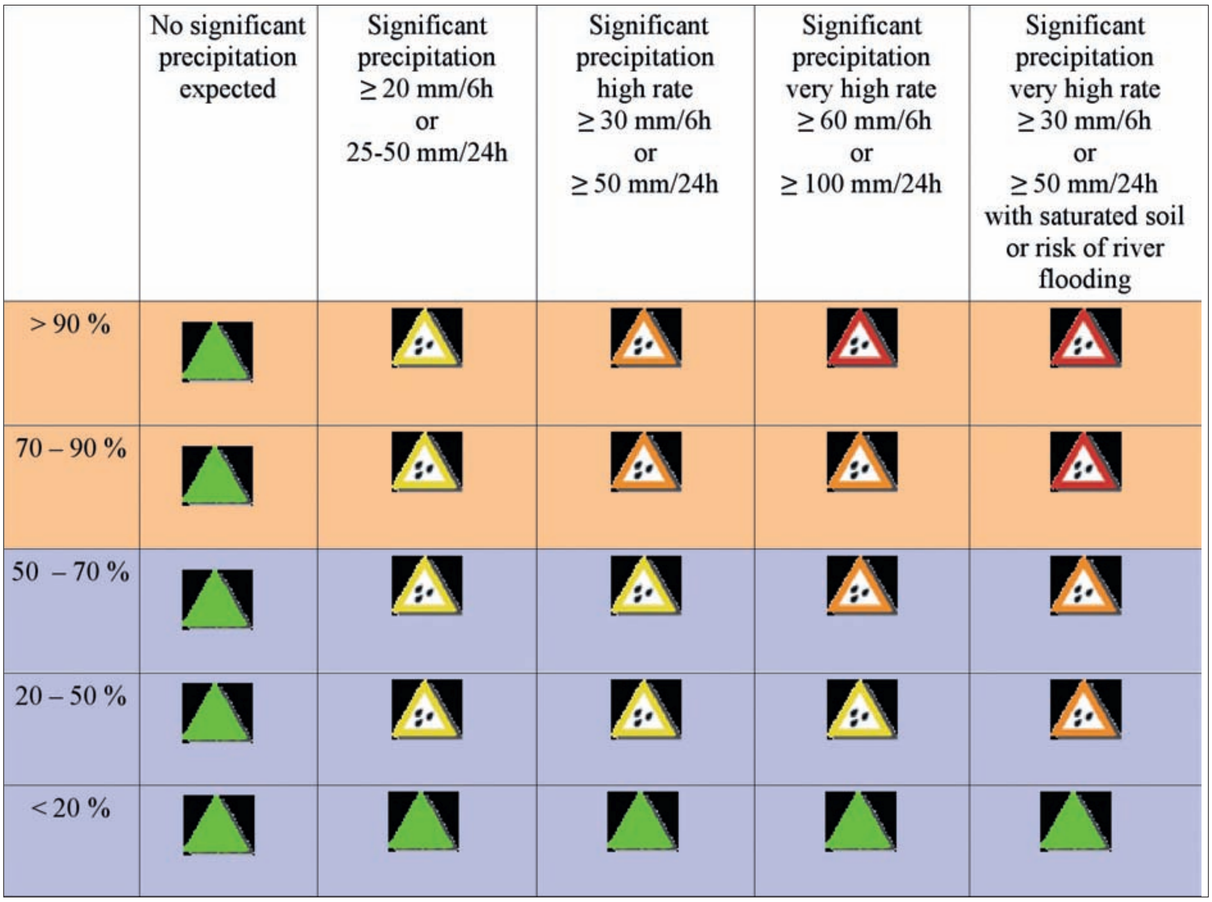
- gusts are forecast in the coastal area.

Example 2. RAINFALL WARNINGS

The potential impact matrix is based on precipitation amounts forecasts with thresholds for a showery regime (high rates but a shorter period given by amount in mm/6h) not associated with thundery activity OR for longer lasting episodes with heavy and continuous precipitation given by accumulation in mm/24h:

- Columns in the matrix show precipitation rates, and rows the estimated risk levels. The icons with symbols and colours represent the potential impact level assessed by forecasters.

The risk level is evaluated as a complex function of several factors:



	No significant precipitation expected	Significant precipitation ≥ 20 mm/6h or 25-50 mm/24h	Significant precipitation high rate ≥ 30 mm/6h or ≥ 50 mm/24h	Significant precipitation very high rate ≥ 60 mm/6h or ≥ 100 mm/24h	Significant precipitation very high rate ≥ 30 mm/6h or ≥ 50 mm/24h with saturated soil or risk of river flooding
> 90 %					
70 – 90 %					
50 – 70 %					
20 – 50 %					
< 20 %					

• Meteorological factors as above, but also considering the effects of stability, strong winds or rapid thaw.

• Surface and soil factors such as surface state and soil moisture along with river flow and height.

• Human and economic factors as above.

DECISION to forecast the IMPACT level

The potential impact level depends both on the forecast precipitation amount and rates exceeding the threshold values AND on the evaluation of the risk level.

The impact level is tuned by forecasters:

A/ the level is increased when

• the timing of the expected precipitation corresponds to peak hours (morning/late afternoon or early evening),

• the location corresponds to more densely-populated areas, in particular in valleys close to the rivers or in coastal and estuary areas,

• successive significant rain episodes are forecast in the short and medium range (ie. in the next 5 to 7days),

• there are strong river flows and high levels,

• soil is wet or saturated,

• rapid thaw from a dense and deep snow cover over a catchment area is expected.

B/ the level is decreased when

• the soil is dry,

• there are low river flow and level,

• no thaw is expected.

Concluding Remarks

The objective evaluation of risks remains a difficult task for forecasters and would be very helpful for the potential impact matrix. The development of ensemble prediction systems for short range forecasts (like GLAMEPS, or at a larger scale ECMWF-EPS) will be tested in the near future to get better meteorological fields and indices giving an indication of the spread of the forecasts and alternative scenarios. We also need the support and the co-operation of authorities and hydrological services to get a more objective assessment of the impact of weather events on society.

For (very) short range forecasts up to 6 or 12 hours the current INCA-BE system seems to be very promising for severe convective weather events, based on those forecast during the summer of 2011. Furthermore a more relevant use of remote sensing data like radar and satellite images (including SAF nowcasting products) is also required by forecasters for their analysis and their nowcasting and should be helpful to issue warnings.