

# KNMI's New Warning System 2015: Towards an Impact-Based Warning System

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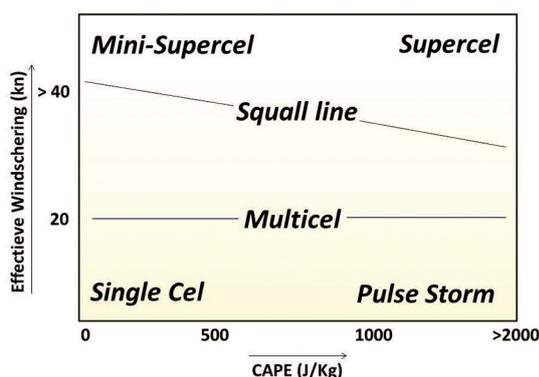
## Introduction

KNMI's current weather warning system for the general public was evaluated in 2015. This led to a list of possible adaptations in the current ways of working. Some of these adaptations could be realized in a rather short amount of time, while others need more time and have to be thought over more thoroughly. In this article the recent adaptations will be discussed and the plans for the future will be briefly discussed.

## Warning Criteria: Thunderstorms Example

The warning criteria were adjusted based on experience and improved meteorological knowledge. Where possible, criteria and colour codes were defined for all meteorological warning parameters. In the case of thunderstorms and extreme temperatures, complete new criteria have been designed. As an example, the new criteria for thunderstorms are presented in the table below. In the past, the number of discharges of lightning were used as a criterion for thunderstorms.

To estimate the severity of thunderstorms, forecasters make use of the so-called "Ingredient Based Forecasting method" (IBF). In this method convection is favorable when the humidity, lift and instability coincide. The severity of the convection is a function of CAPE (conditional available potential energy) and the effective vertical wind shear (see fig. 1). The type of CAPE which is used depends on the specific meteorological situation, and whether convection is surface based or elevated.



▲ Figure 1: Organization of convection as a function of CAPE and effective (vertical) wind shear.

## Impact Assessment for Code Red

Another important change is the way of issuing a code red, the so-called "weather alarm". A highest level, red warning will now only be issued based on expected impact. This means that a code orange – based on meteorology - can be changed into a red warning when impact is considered as well. To realize this, in principle, a code red has no formal meteorological threshold; the former threshold for areal size (50x50 km) has been left, as well as the probability of the event of 90%.

The impact assessment is done by the CPAs (Civil protection authorities) and departments which are responsible for infrastructure. This so-called Weather Impact Team is chaired by the Dutch DCC (Departmental Crisis Centre). Meetings of this team can be

**Thunderstorms**  
Local thunderstorms with one or more of the following phenomena:

- gusts (>60 km/h),
- And/or locally >30 mm/h precipitation,
- And/or hail size up to 2 cm.

Organized thunderstorms with one or more of the following phenomena:

- severe gusts (>75 km/h),
- And/or locally >50 mm/h precipitation,
- And/or hail size 2-4 cm.

\*Well organized thunderstorms with one or more of the following phenomena:

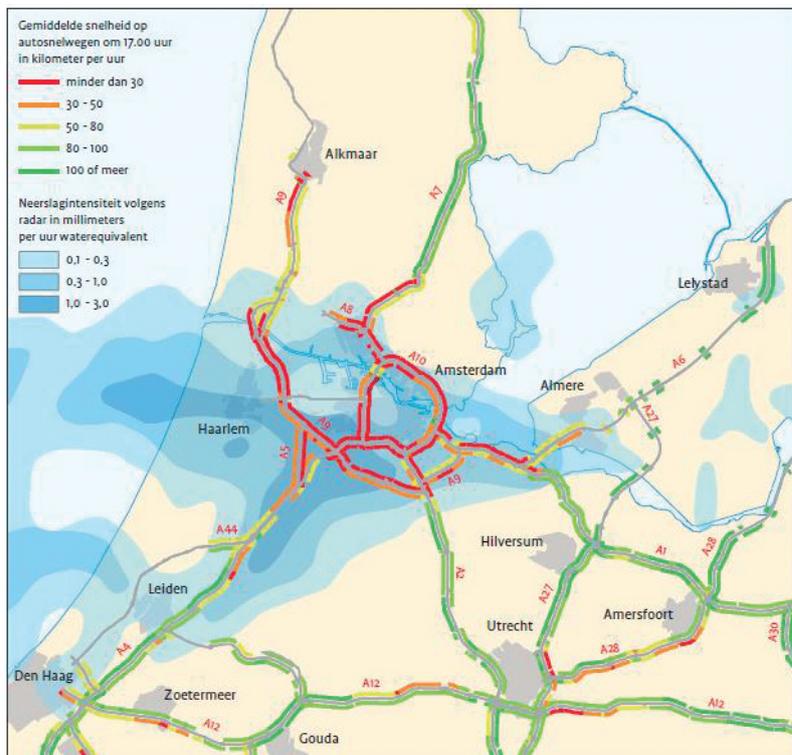
- severe gusts (>100 km/h),
- And/or locally >75 mm/h precipitation,
- And/or hail size >4 cm.

\*This is an internal guideline for a code red, as a code red is fully impact-based.

arranged 24/7 by means of a telephone- /video conferencing system. Within half an hour such (virtual) meetings can be arranged. The meetings start with a short meteorological outline and is followed by an overview of the (expected) impact in the different critical fields of interest. At the end of the short meeting the DCC advises KNMI. It is KNMI's decision to issue the code red. In rapidly developing situations, KNMI is mandated to issue a code red instantly without intervention of a Weather Impact Team. This was also the case during the Pentecostal severe thunderstorm (bow-echo) on 9th June 2014 (Fig. 3). The storm caused serious injuries and some casualties in the western part of Germany, close to the festival site.



▲ *Figure 3: Pentecostal thunderstorm, 9th of June 2014. A severe thunderstorm (bow-echo) almost hits the site of the PinkPop festival with approximately 60000 visitors. A code red was issued instantly 1.5 hours in advance when it was very likely that the thunderstorm would hit this location.*



◀ *Figure 2: Example of a minor meteorological event with major impact. Small snow showers from the North Sea moving over the capital city of Amsterdam. (6th Jan. 2010) Blue: radar reflectivity, lines indicate highways and colors indicating traffic speed (red: less than 30 km/h)*

## User Perspectives and Description of Possible Impact

All weather warnings will be from now on accompanied by general handling advice and description of possible impact. In the table below an example for wind gusts is given.

## Future plans

For the near future, in 2016-2017 it is our great wish to make the weather warnings more tailored towards the end-user. A great way to communicate this is to work with an app for smartphones. This needs a step in further regionalization of warnings (as nowadays we warn on province-level). To realize this, new tools have to be developed and other ways of operational working have to be devised. An example of regionalization can be viewed in fig. 4.

Secondly it is our wish to broaden the impact-related way of warning concerning all the colour codes. This will ask more and more of the departments which are involved in crisis coordination that have their antennae within society, mainly into the departments and civil services which are responsible for transportation and infrastructure.

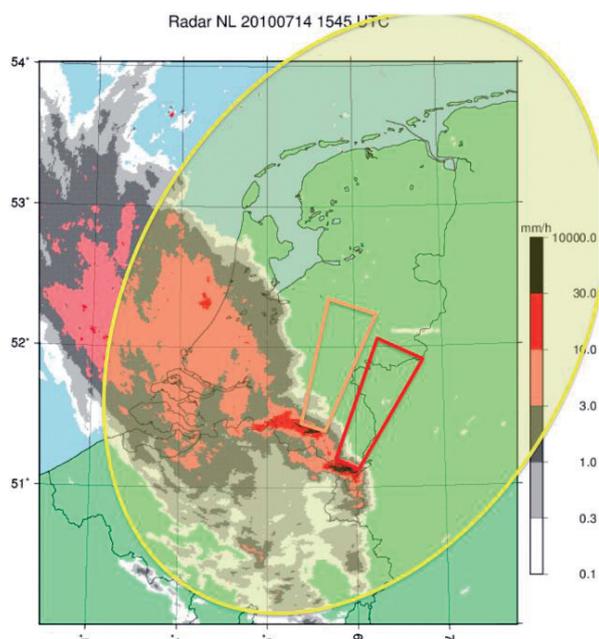
	No warning	Be alert	Be prepared	Take Action, Weather Alarm
Advice with respect to wind gusts to wind	No big problems expected due	Risk wind gusts Traffic and outdoor activities can encounter problems Be informed about weather forecasts and warnings	Danger due so severe wind gusts Risk of falling trees and falling tree branches Take measures to prevent damage or injuries Hazardous situation for traffic and outdoor sports. Be prepared if you take a journey and be aware of longer travel time. Be informed about weather forecasts and warnings	Extremely severe wind gusts with danger for humans. Risk of falling trees and falling tree branches Take action to prevent damage or injuries Don't go on open water. Don't travel unless absolutely necessary Be informed about weather forecasts and warnings

In the end it is the shared responsibility of KNMI as public institute to serve society as a whole on the best possible way to ensure a safe and durable way of living.

## References

Doswell, C, A., III, H. E. Brooks and R. A: Maddox, 1996: Flash Flood Forecasting: An Ingredients-Based Methodology. Wea. Forecasting, 11, 560-581.

Revisiting the severe Bow-Echo of Pentecost 2014 in West Germany <http://www.sturmjaeger-nrw.de/bow-echo-western-germany-pentecost-2014/>



◀ Figure 4: Regional approach for issuing severe weather warning. Orange and Red boxes correspond with the area where code orange and red conditions are expected in the coming hour.