PRIMAVERA

PRocess-based climate sIMulation:
AdVances in high-resolution modelling
and European climate Risk Assessment

Flooding impacts on the European transport system

Intense rainfall can cause direct significant and long lasting impacts on transport operations, due to flooding, while indirectly impacting transport safety and bringing damage to transport infrastructure. Submerged roads and railway tracks become unusable, towns become inaccessible, movement of people and goods becomes disrupted, and floods could even lead to human casualties.

Knowledge about projected future changes in extreme rainfall events and in factors contributing to the occurrence of floods is needed. Such knowledge, combined with better understanding of the transport sector's vulnerability to these events, will allow transport organizations to develop strategies to minimize the potential risks brought about by changes in the characteristics of flood events in the future.

What are flood events?

Flooding occurs when areas not normally submerged become inundated by surface runoff, overbank river flows or groundwater. Pluvial flooding may occur when intense convective precipitation falls in a short period of time, or when prolonged moderate to heavy precipitation falls due to a front being stalled over an area or due to the passage of several consecutive storms over time. During such precipitation events, the ground may become saturated and no longer able to absorb the falling rain which leads to heavy surface runoff reaching rivers and flooding the surrounding areas. This is especially disruptive in cities, where the ground is often covered by impermeable surfaces, that do not allow infiltration of the rain water. The city waste-water drainage systems may not be able to cope with the large amounts of falling rain. Rivers can also become overwhelmed by surface runoff and intense precipitation, and burst their banks (river flooding) contributing further to the extent and impacts of a flood event.

What conditions lead to flooding?

A range of different meteorological conditions can lead to heavy rainfall and flooding. Flood events can result from strong convection leading to intense rainfall; or when several successive low pressure systems affect an area over a prolonged period of time, bringing humid and unstable air. Sometimes a slow moving cyclone allows large amounts of water vapour to precipitate over a region, saturating the soil and leading to heavy surface runoff. Flooding can also happen when a deep and intense low pressure system brings air masses with highly contrasting characteristics leading to heavy precipitation, strong winds, lightning and even hail. The frequency and path of low pressure systems affecting an area are highly dependent on the location of the storm track.

Flooding of the railway at Cowley, Exeter, UK – 20 Oct. 2014 (Photo from: https://www.networkrailmediacentre.co.uk/resources/)

Funding

This project has received funding from the European Union's Horizon 2020 Research & Innovation Programme under grant agreement no. 641727.

Info

PRIMAVERA is a collaboration between 19 leading European research and technology organisations with complementary expertise in climate science, climate change modelling, and high performance computing.

The project is led by the Met Office and the University of Reading.

Media

www.primavera-h2020.eu

Watch the project video →

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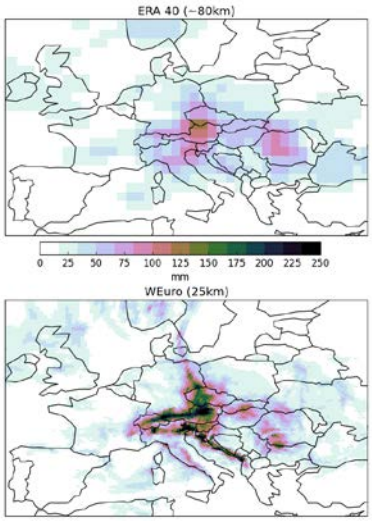
How does flooding affect the transport system?

Some examples of transport impacts include:

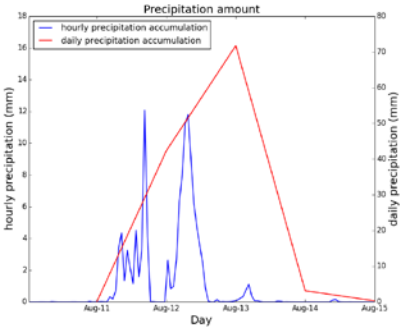
- **Rail** – delays and line closures, due to flooding of the track or lineside equipment, or to flood-related debris on tracks; track damage (e.g. ballast washout); embankment scour and washout; bridge scour; flooding of depots; landslips; embankment landslides; overwhelmed railway drainage in cuttings.
- **Road** – structural damage from water and debris, such as road edges erosion, subsidence and heave; embankments and culverts damage; landslips.
- **Air** – flooding of runways; limited or lack of access to/from airports.
- **Inland waterways** – disruption of operations due to river flooding and debris accumulation.
- **Marine** – flooding of port infrastructure.



Intense precipitation event leading to flooding in 2002 represented by two datasets with different resolution. The ERA 40 reanalysis with approx. 80km resolution and the WEuro dataset with a 25 km resolution. The finer resolution dataset provides greater detail in the mountainous areas of Central Europe. See more about the events in these "Weather" papers: Part 1 http://dx.doi.org/10.1256/wea.61.03A Part 2 http://dx.doi.org/10.1256/wea.61.03B

What do current climate models say about future precipitation?

Precipitation is projected to increase throughout this century in Northern Europe and decrease in Southern Europe. Across Europe as a whole, a marked increase of heavy precipitation events is also expected which will lead to rise in river flood risk and without adaptive measures will bring greater flood damages (Kovats et al. 2014).



Example of daily and hourly rainfall from a high-resolution model. The sub-daily detail could be more useful to (for example) drainage engineers, who need to ensure resilient drainage assets on road or rail networks.

How can the PRIMAVERA simulations help?

The PRIMAVERA project is developing a new generation of advanced high-resolution global climate models, capable of simulating regional climate with greater fidelity. The increased temporal (sub-daily) and spatial resolution (typically around 25km) of the PRIMAVERA models has the advantage of allowing better representation of physical processes leading to heavy convective precipitation, and of features related to flooding, such as storms, storm tracks, and blocking structures, which often deflect the storms on their paths.

References:

- Kovats, R.S., et al. 2014: Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of WG II to AR5 of the IPCC [Barros, V.R., et al. (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1267-1326.

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