



**RAIN**  
PROJECT

RISK ANALYSIS  
OF INFRASTRUCTURE  
NETWORKS IN RESPONSE  
TO EXTREME WEATHER

**FINAL ACHIEVEMENTS**

# EXTREME WEATHER EVENTS AND INFRASTRUCTURE: ASSESSING THE IMPACTS, MITIGATING THE CONSEQUENCES

RAIN is a European research project started in 2014 and completed in April 2017. The main aim of the project was to quantify the complex interactions between extreme weather events and land-based infrastructure systems.

Transport, energy and telecommunications infrastructure have been considered and risk mitigation strategies have been developed. This has been achieved through developing an operational analysis framework which considers the impact of individual hazards on specific infrastructure systems and the coupled interdependencies of critical infrastructure through robust risk and uncertainty modelling.

The outputs of RAIN aid decision making in the long term, securing new robust infrastructure development and protection of existing infrastructure against climate change and increasingly more unpredictable weather patterns.

## FACING EXTREME WEATHER EVENTS

During the project researchers have sought answers to three main questions.

### How has Europe addressed the problem so far? What can be improved?

RAIN has investigated the consequences of past extreme weather events, and assessed how state-of-the-art early warning systems are used to mitigate them. Increasing data availability, and supporting efforts to monitor, forecast and study hazards on a European level are considered to help to increase resilience to extreme weather impacts on critical infrastructure and society as a whole.

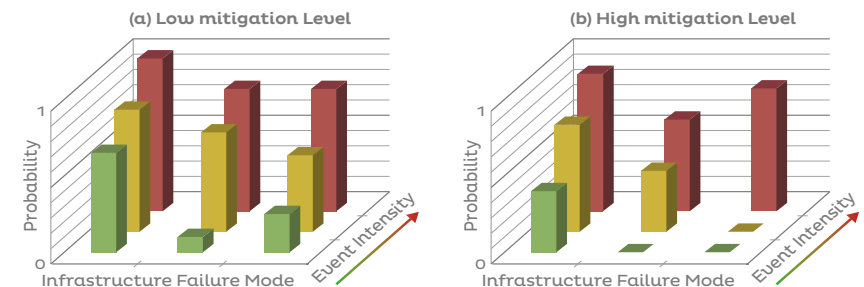
RAIN also identifies measures including physical adaptations and changes to management strategies to increase the level of redundancy and mitigate the consequences of cascading effects.

### How can infrastructure owners/managers be more prepared for extreme weather events?

RAIN has developed methodologies to identify the critical land transport infrastructure and has reviewed historical failures which have resulted from extreme weather events. In addition, it has provided a means to estimate societal vulnerability as a consequence of infrastructure failure. To help infrastructure owners/managers, RAIN has developed a self-assessment tool to measure the level of the preparedness for extreme weather events at region and municipal levels. The project has also provided insight into those criteria that will contribute most to enhance resilience.

### Is it possible to enrich risk assessment methodologies in order to be better prepared for extreme weather events?

RAIN has developed a novel Risk-based decision-making framework for single and/or multiple hazard events. This framework combines both, the nature and extent of risk, the consequences of the infrastructure failure, and the mitigation effect upon the corresponding levels of damage, allowing the identification of optimal strategies which reduce risk to acceptable levels.



**Risk-based decision-making framework developed by RAIN project**  
Failure probabilities of the critical infrastructure under potential scenarios of extreme weather events when applying different mitigation measures.

Critically, this robust methodology facilitates the consideration of the cascading effects, i.e. those effects which are caused by the interdependencies between critical infrastructure networks.



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