

Climate Resilience POC

Downburst modelling results

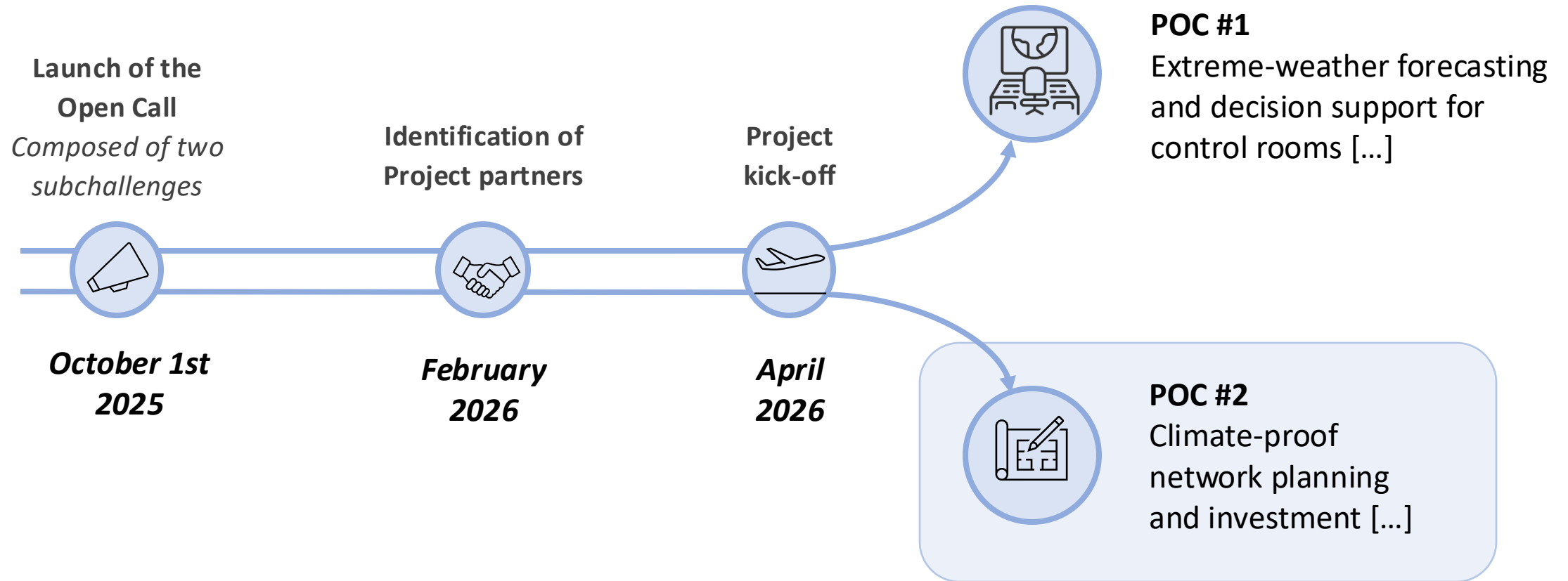
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Project Overview

Timeline

From identification of the challenge to implementation of the solution



PoC #2 Overview

Three work streams, developed in the context of the *Grid Innovation Alliance*, with  refinq

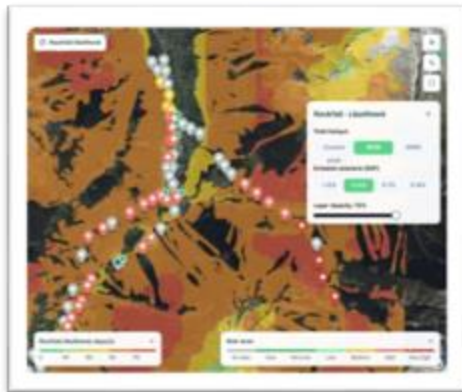
1

Rockfall

LEAD TSO: Swissgrid

PROJECT TYPE: Custom development

The Rockfall use case develops a methodology to assess the risk of rockfall on individual power grid assets in an alpine environment. The model combines the likelihood of event triggering, boulder reachability and impact energy, while accounting for climate change and forest cover, to support the planning and prioritization of mitigation measures.



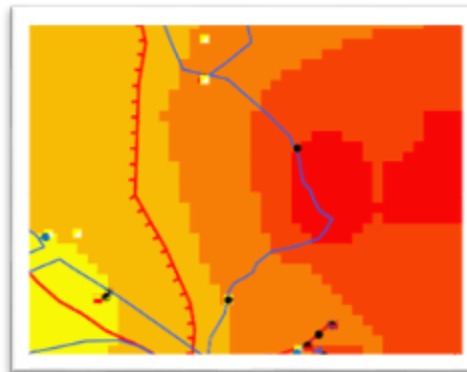
2

Extreme Wind - Downburst

LEAD TSOs: Terna and Elia

PROJECT TYPE: Custom development

The project focused on downbursts, including historical event reconstruction, event classification, likelihood and return period analyses, and climate-based projections to support grid resilience. A complementary analysis of extra-tropical cyclones (ETCs) was conducted to distinguish synoptic and convective wind contributions and assess future changes in extreme wind speeds.



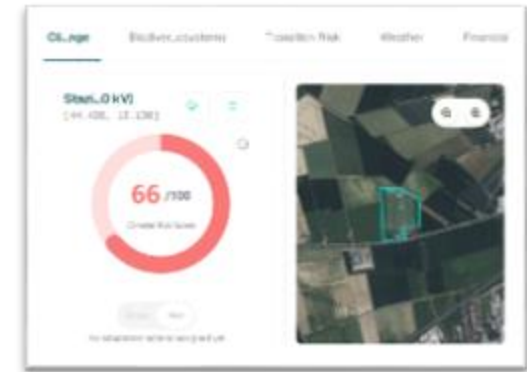
3

Baseline service

TSOs Involved: All

PROJECT TYPE: Testing baseline platform features

The Baseline Services consist of the set of standard services of the refinq platform, which provide a multi-hazard assessment of climate risks at the level of individual assets. The platform integrates over 25 climate and environmental hazards, combining hazard, vulnerability and exposure to support planning, maintenance and investment activities with a view to climate resilience.



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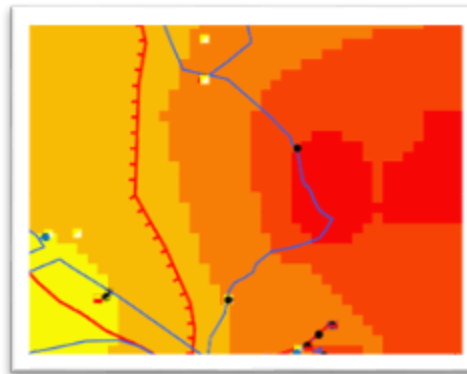
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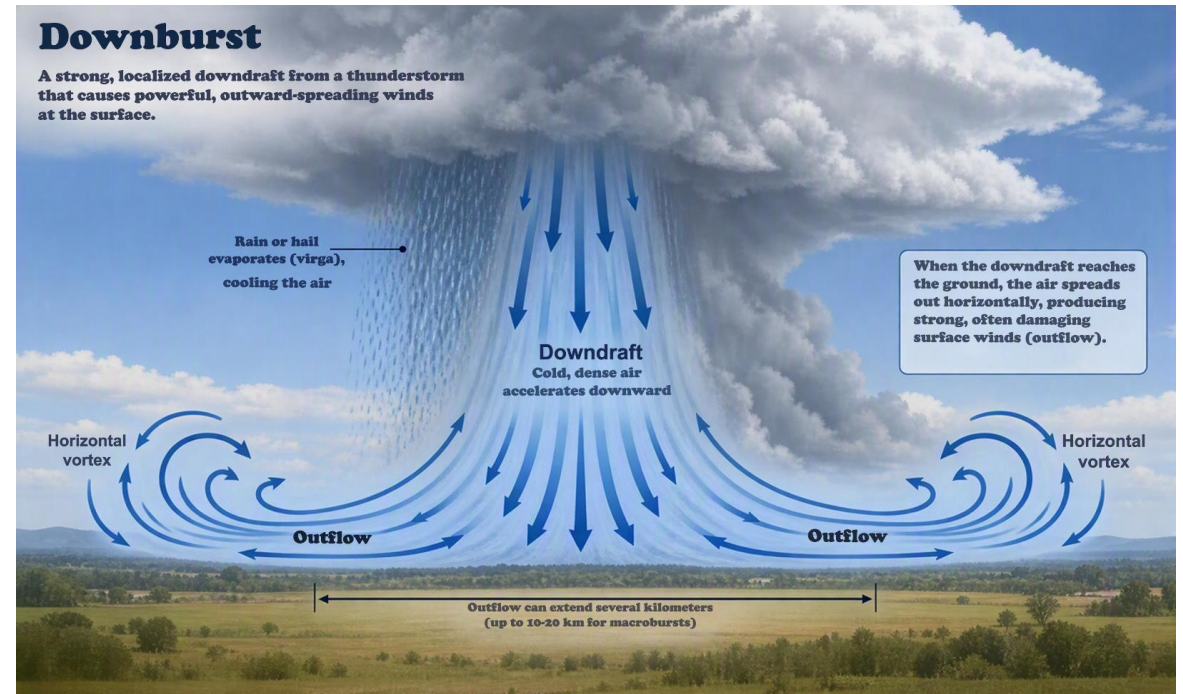
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Downburst Features

Downbursts differ from synoptic winds in several key aspects

- Sudden and intense gusts (>160 km/h)
- Anomalous vertical wind profile
- Simultaneous impact on several spans: despite being localized phenomena, downbursts can exceed 4 km in diameter
- High turbulence and rapid changes in direction
- Higher probability in inland areas than on the coasts



Platenkamp, E. (TenneT), Landerink, G. (KNMI), Stoop, L. (TenneT) & Borger, T. (DNV), **Study on the Impact of Downburst Events on Overhead Lines in the Netherlands in Relation to Climate Change**, CIGRÉ, 2026.

Objectives and methodology

Use Case Requirements

The requirements of the Downburst Use Case, organized in objectives and expected output

Objective

Expected output

RECONSTRUCTION OF HISTORICAL PHENOMENA



- **Reconstruction/modeling of historical** meteorological phenomena related to events that caused damage to the infrastructure.
- **Certification** of the **classification** of the type of phenomenon reconstructed.



Detailed reports on the model adopted



Classification and characterization



A map reconstructing the event with speed reached

HISTORICAL AND FUTURE HAZARD MAPS



- Evaluation of the **historical probability** of occurrence as a function of the intensity.
- Evaluation of the **future probability** of occurrence as a function of the intensity, considering the **RCP 8.5 emission scenario and the horizon year 2035**.



Historical probability of occurrence maps



Future probability of occurrence maps, considering the RCP 8.5 emission scenario and the horizon year 2035

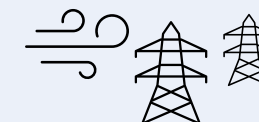
VULNERABILITY ANALYSIS



- Prepare a **detailed report** of the vulnerability analysis tool already present in the solution offered by the provider, with a section linked to specific case studies.
- **Assessment of assets affected** by the climate phenomenon through vulnerability analysis tools.



Detailed Report on the vulnerability analysis



Identification of the most exposed assets

Key parameters considered

DEI

Definition

Downburst Environment Index (DEI), a parameter that combines a thermodynamic term (cold-pool strength) and a kinematic term (updraft intensity multiplied by shear in deep layers), between -2 and 2;

The DEI indicates how favourable atmospheric conditions are for downbursts. It does not indicate whether an event occurred or the associated wind speed.

Output maps

- Three-hour maps of the DEI used for the reconstruction of events.
- Maps of the favorable days of DEI per year [DEI-days per year]: the number of days in which the maximum daily value of the DEI exceeds threshold = 1, processed both historically and prospectively (2035, 2050, 2100) in the 3 RPCC scenarios, with a resolution of 1 km.

Wind gusts

The maximum wind gust is not an input data for the DEI because it is an independent quantity, which derives from observational and reconstructed data.

Maps of the reconstruction of historical events representing the maximum wind gust, i.e. the maximum value recorded over an hour in km/h at 10m height

Return Period

The return period is therefore based on the correlation between favorable days and recorded events, calculated only where the events were recorded, i.e., in practice, in populated areas.

$$T = 1 / (k \times \text{DEI-days} \times A)$$

Where:

k converts days with favorable environmental conditions into events

A is a representative area of analysis

Maps of the probability of occurrence of the downburst at 1km resolution, both historically and prospectively (2035, 2050, 2100) in the 3 RCP* scenarios

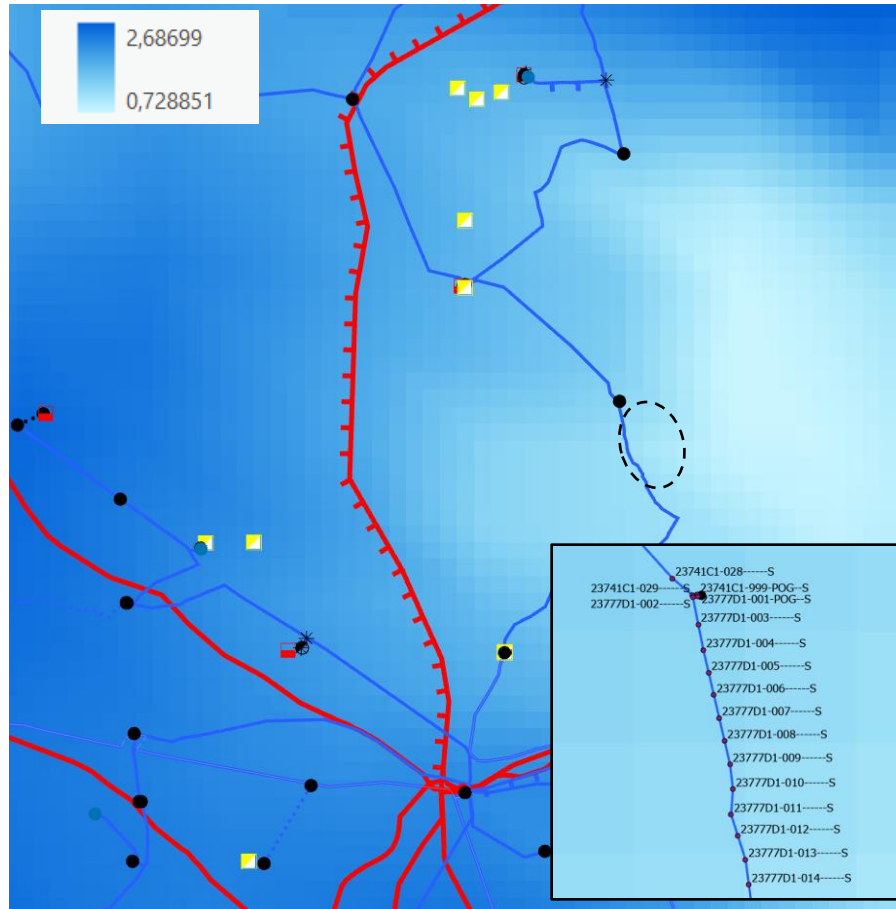
*Representative Concentration Pathways

Output

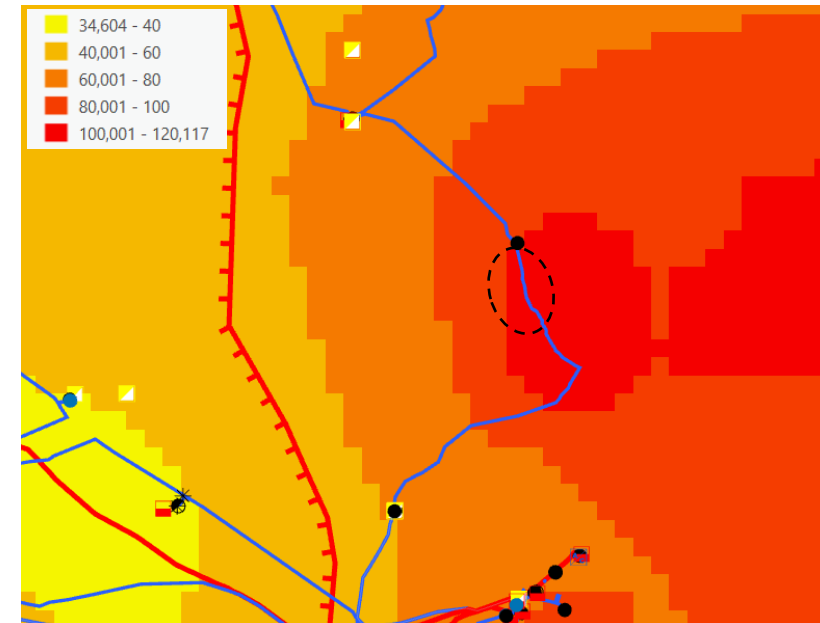
Focus on: *RECONSTRUCTION OF HISTORICAL PHENOMENA*

Event: Ravenna 10/08/2017 14:55 CEST

DEI downscaled @ 12:00 UTC



Wind gust @12:00 UTC (km/h)

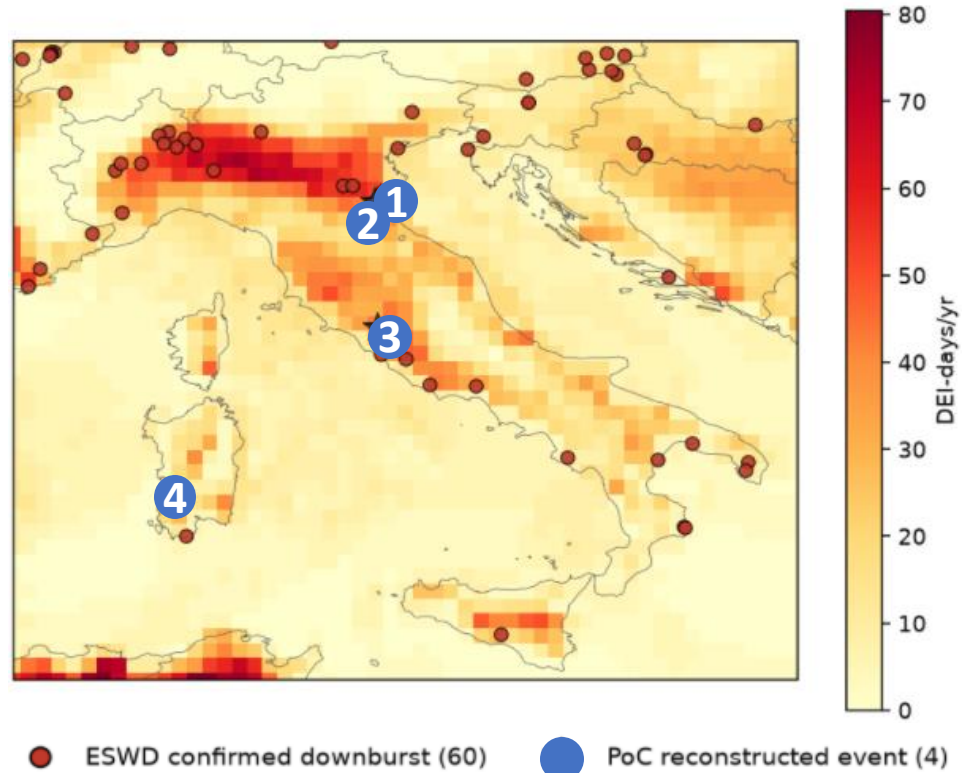


The DEI map identifies the areas where the conditions are most likely to occur. At the damaged location, the DEI was 1.22, above the threshold of 1. Reconstructed wind gusts slightly exceeded 100 km/h

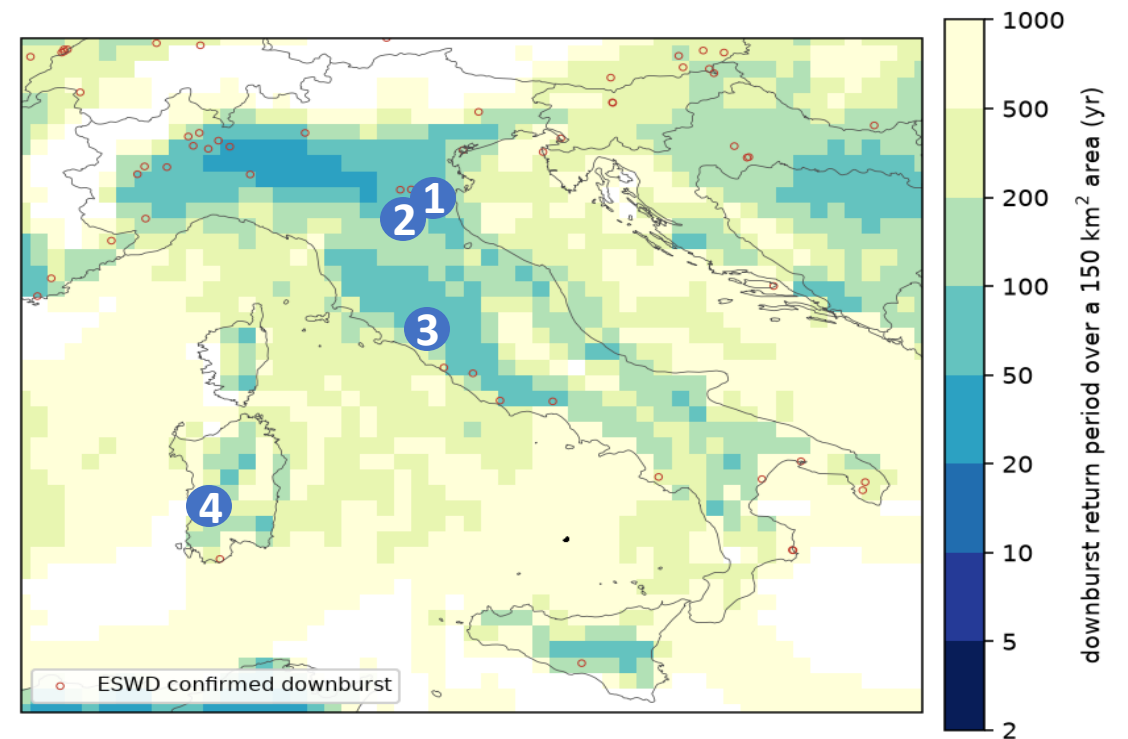
Focus on: *DEI-DAYS VS RETURN PERIOD HAZARD MAPS*

Historical maps obtained using the ERA5 re-analysis dataset without downscaling with ~ 55 Km resolution

DEI-days/yr



Return Time



The correspondence between the areas with a higher value of DEI-day/yr and the areas with a higher RP is qualitatively good.

Focus on: *VULNERABILITY ANALYSIS*

Methodology used by Refin

Step 1 – Basic Vulnerability Industry and asset type



The vulnerability assessment starts from a baseline value assigned to all power transmission assets based on the NACE D35.12 classification.

0.5

Step 2 – Adaptation for the asset category



The baseline value is then corrected according to the type of asset analyzed, distinguishing for example between electrical substations, pylons and overhead lines.

↑ ↓
0-1

Step 3 – Asset-specific modifiers

Vulnerability is defined on the basis of the construction characteristics of the support and combined through a logic of penalised summation. Among the criteria considered, there are the type of support, the type of foundation and the age of the element.

↑ ↓
0-1

Conclusions

Conclusions

What we learned and the way ahead

Lessons learned

- **Downbursts differ from synoptic winds. Their implications for asset vulnerability** require further assessment.
- An **innovative methodology was developed** to estimate the likelihood and return periods of downbursts. Further validation is needed.
- Climate projections suggest an **increase in severe convective activity**
- Collaboration within the Grid Innovation Alliance enabled **methodological exchange** and **comparison of results** across countries.

Open points

- Is the **impact of downbursts on infrastructure** already adequately represented in current wind hazard maps?
- Do **current vulnerability models and design standards** adequately capture downburst effects on grid assets?
- How can downburst occurrence probability be linked to the associated **wind gust intensity**?

Thank you