

THE PROBLEM

Power-line grids extend across territories affected by different natural hazards. Floods and wildfires can disrupt assets and services through distinct physical processes, while conventional assessments often remain separated by hazard and are difficult to compare.

A common spatial framework is needed to connect environmental conditions, exposed elements and asset-specific vulnerability, transforming heterogeneous data into information that can support prevention and planning.

THE EO APPROACH

The proposed service combines Copernicus observations, open geospatial information, historical hazard archives and customer grid data.

The key points of the approach are:

- Independent and repeatable observations
- Large-area coverage
- Integration with ancillary and customer data
- Scalable production

ACKNOWLEDGEMENTS

This work was developed within an EUSPA-funded demonstration project focused on applying Copernicus data and services for energy-network planning and risk assessment.

KEY RESULTS

86 % Flood hazard validation in Aragon

80 % Flood hazard validation in Catalunya

80 % Wildfire hazard validation in Aragon

91% Wildfire hazard validation in Andalucia

REFERENCES

Granger et al. (1999) · Peck et al. (2007) · Chaparro et al. (2016) · Hantson et al. (2016) · Walegnn & Zeleke (2019) · Novo et al. (2020) · Sammartino et al. (2021/2022).

Author

Sara Ciaccia
ciaccia@planetek.it

Elisa Ilardi
ilardi@planetek.it

Walter De Simone
desimone@planetek.it

Planetek Italia s.r.l. Società Benefit
<https://www.planetek.it>

STUDY SITES

Four areas in Spain were selected together with the end user according to operational requirements, territorial characteristics, and risk exposure. The selected study sites represent areas that have been particularly vulnerable to the analysed hazards in the past, either because of recurring events, environmental conditions, or the presence of assets potentially affected by these phenomena. Approximately 500 km² were analysed for each hazard.

FLOOD - ARAGON

ZARAGOZA
246 km²

FLOOD - CATALUNYA

BARCELONA
247 km²

WILDFIRE - ARAGON

ARAGON / CASTILLA Y LEON
243 km²

WILDFIRE - ANDALUCIA

ESTEPONA
260 km²

WORK LOGIC

FLOOD – EO & OPEN DATA

- Historical Flood Data (10-90 m) → EEA River Flood Hazard Maps, MITECO Flood Hazard Maps, Sentinel-1/2
- Land Cover / Land Use (10 m) → ESRI Land Cover
- Digital Elevation Model (DEM) (25 m) → MDT25
- Slope, Curvature, Topographic Wetness Index (25 m) → derived from DEM
- Curve Number (CN) (10 m) → derived from LULC
- Population Density (250 m) → JRC GHSL
- Built-up Surface / Economic Exposure (100 m) → JRC GHSL
- Infrastructure Layers (vector) → OpenStreetMap
- Protected Areas (vector) → MITECO

PRE-PROCESSING



HAZARD MODELS



EXPOSURE & VULNERABILITY



RISK PRODUCTS

WILDFIRE – EO & OPEN DATA

- NDVI (10 m) → Sentinel-2
- Land Cover (100 m) → Copernicus CORINE Land Cover
- Tree Density (10 m) → Copernicus Tree Cover Density
- Land Surface Temperature (30 m) → Landsat 8
- Wind (4 km) → TERRACLIMATE
- Soil Water Index (12.5 km) → Copernicus CLMS
- Elevation, Slope, Aspect (25 m) → MDT25 and DEM-derived layers
- Population Density (250 m) → JRC GHSL
- Anthropic Elements and Water Bodies (vector) → OpenStreetMap
- Historical Wildfires (vector) → EFFIS and MITECO archive

FLOOD RISK METHODOLOGY

Flood susceptibility is modelled through terrain, hydrological and land-surface factors. Elevation, slope, curvature, Topographic Wetness Index, hydrographic context, land cover are integrated with historical flood evidence.

Frequency Ratio model

The Frequency Ratio is calculated as the ratio of the probability of flooding in areas with a specific factor class (e.g., low slope) to the probability of flooding across the entire area. Each conditioning factor is divided into five classes. The ratios quantify the relationship between observed floods and each factor class. The, they are combined into a spatial hazard surface.

Vulnerability and exposure

Flood vulnerability integrates social, environmental, economic and infrastructure components. Matrix-based combinations of exposure, vulnerability and hazard generate the final flood-risk product.

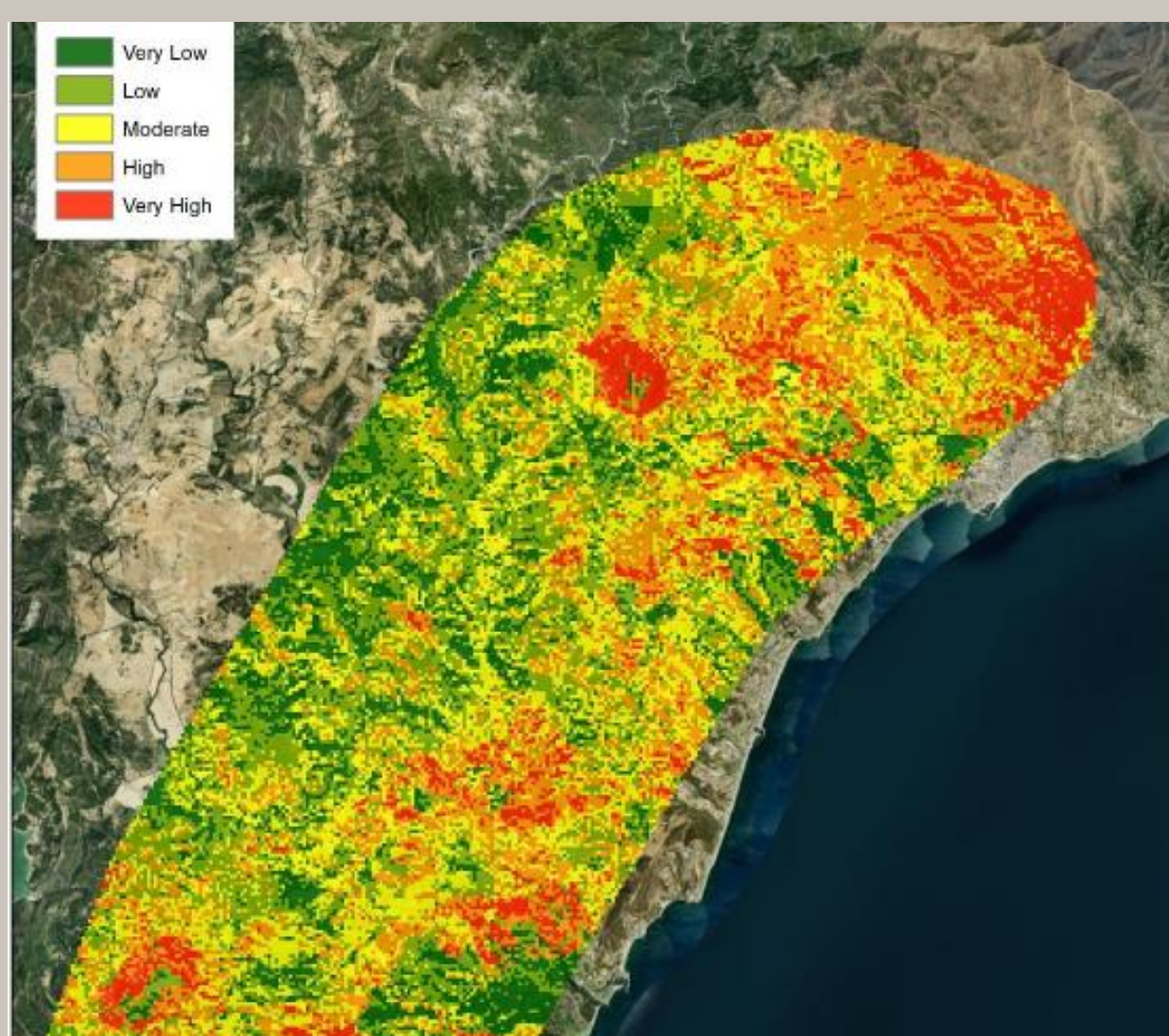


Figure 2 – Wildfire risk map on Andalucia area

HAZARD → + VULNERABILITY → + EXPOSURE → RISK

The final risk map combines hazard with population exposure and social, environmental, economic and infrastructure vulnerability.

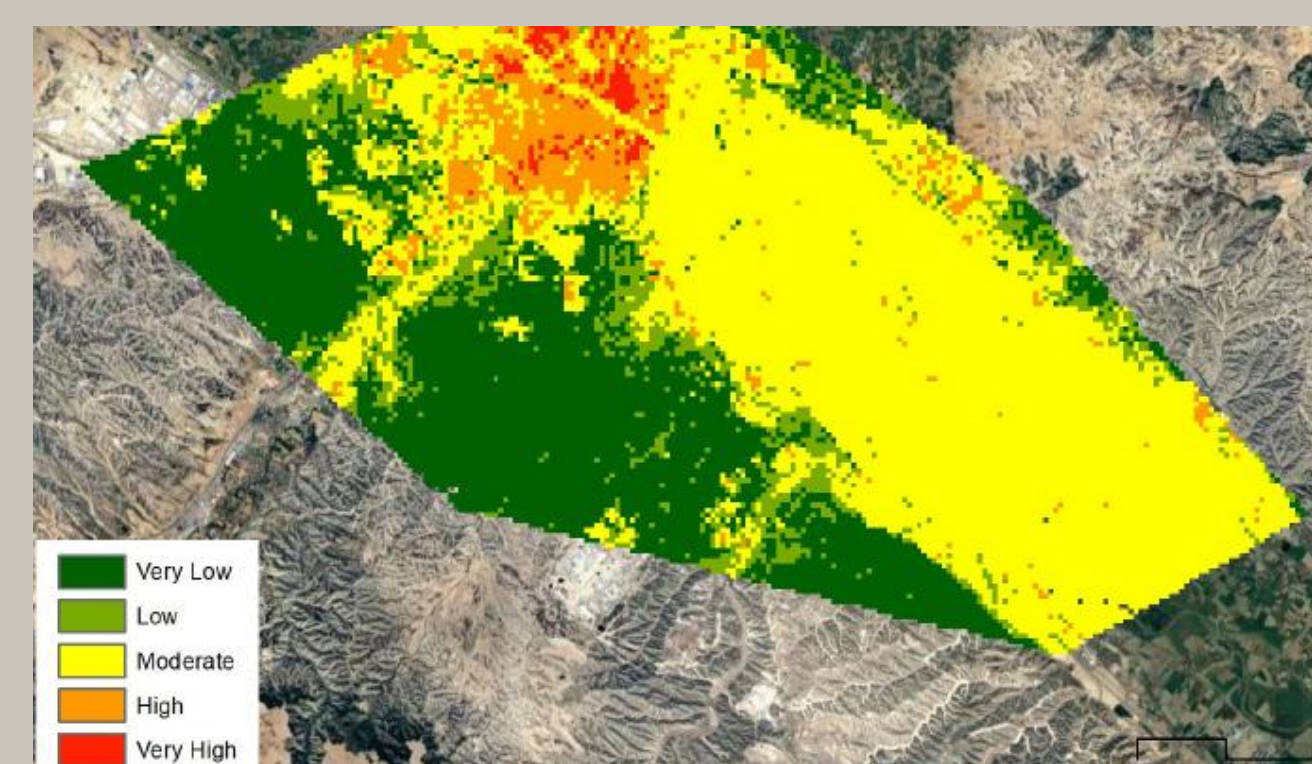


Figure 1 – Flood risk map on Aragon area

WILDFIRE RISK METHODOLOGY

Wildfire susceptibility incorporates biological, climatic, anthropogenic and topographic factors. Variables include land cover, NDVI, vegetation density, surface temperature, soil water, wind, proximity to roads and settlements, elevation, slope and aspect.

Analytic Hierarchy Process method

Analytic Hierarchy Process (AHP) methodology was adopted to solve complex decision-making problems by breaking them down into simpler, more manageable subproblems. All identified factors are normalised from 1 to 5. Pairwise comparisons assign their relative importance and a consistency check is applied before combining them into susceptibility, probability and vulnerability components.

Hazard and risk construction

Historical wildfire frequency and time since the last event define probability. Territorial vulnerability, customer grid vulnerability and population exposure are progressively included to obtain risk.

POWER-LINE RISK ASSESSMENT

Territorial maps provide the environmental context, but network operators need information directly matched with individual infrastructure elements. The asset-level workflow spatially intersects flood and wildfire hazard classes with the power lines geometry and combines them with available technical attributes. For each line or span, a vulnerability score is calculated based on parameters such as voltage level, support or tower type, foundation characteristics, span configuration.

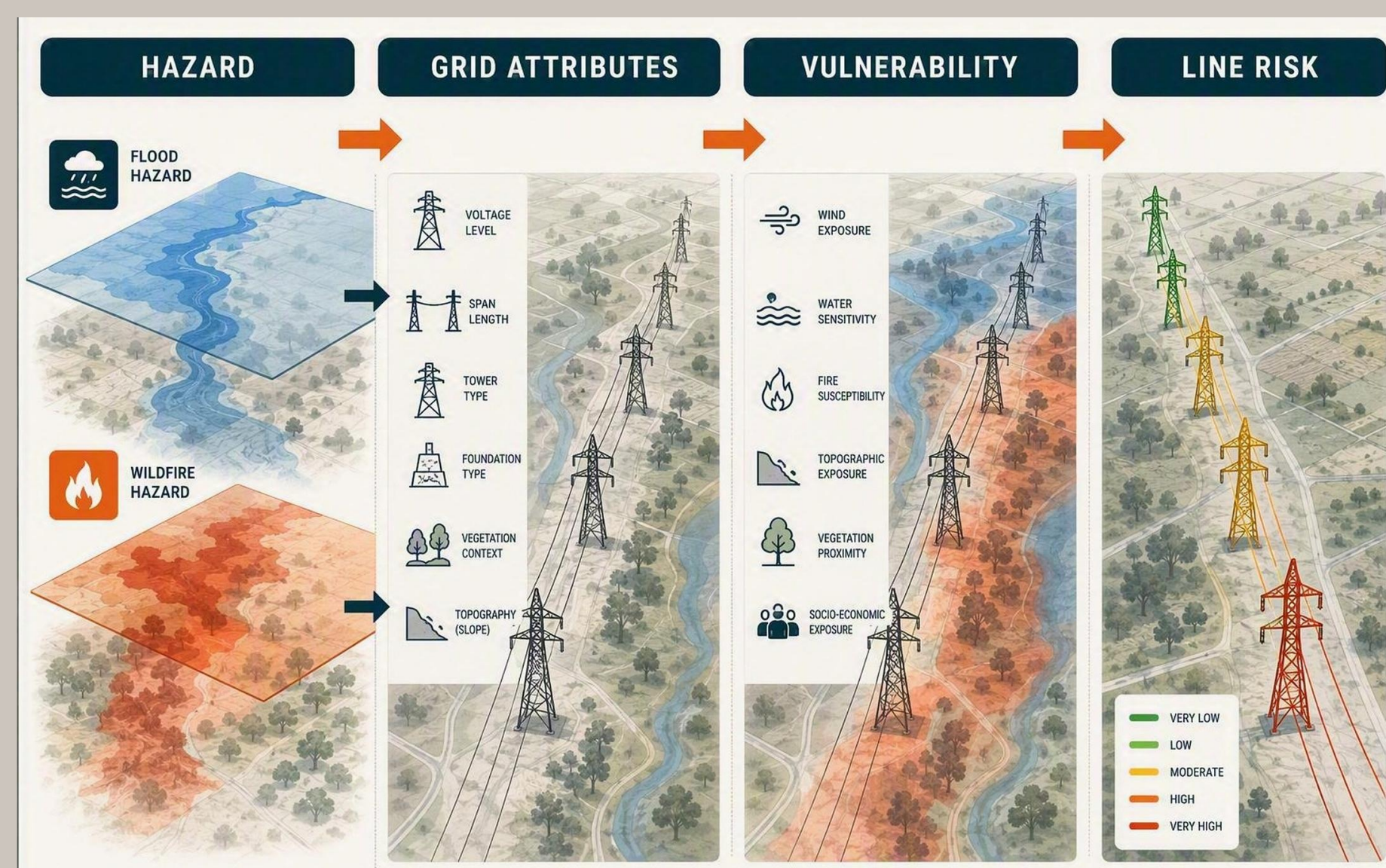


Figure 3 – Illustrative graphics created using generative AI and reviewed by the authors

CONCLUSION

The study shows that EO-derived environmental information can be combined with open datasets and customer network characteristics to produce consistent multi-risk intelligence. The approach is scalable to different regions, customisable to asset information and suitable for integration with existing assets. The maps provide a medium-term planning perspective and should be updated periodically, particularly where land use, population or infrastructure changes. Through the webGIS, users can explore hazard and risk layers, filter grid vulnerability classes, inspect attributes and compare spatial products. This converts heterogeneous data into actionable information for preventive planning, targeted mitigation and more resilient electricity networks.