Climate module for Railway infrastructures risk management

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THE PROJECT

IU-RESCAT/C3 and ETS Srl are collaborating on an innovative project to **adapt risk management in railway infrastructure** to the effects of climate change. As climate change poses various challenges to the transportation sector, particularly to railways, **this joint effort aims to enhance the resilience of railway systems** in the face of changing environmental conditions.

AN UNIVERSITY – INDUSTRY CONSORTIUM to boost climate change adaptation measures

IU-RESCAT/C3 (URV), known for their **expertise in climate science, climate services, and climate change adaptation**, brings their knowledge and experience to the table. They provide valuable insights on identifying vulnerabilities and potential impacts of climate change on railway operations.

On the other hand, ETS Srl specializes in engineering and technology solutions for railway systems. Leveraging their technical capabilities, they contribute to the project by developing innovative methodologies and technologies to adapt existing railway infrastructure to climate change-induced risks.

THE BACKGROUND

IURESCAT/C3 has led projects in both climate database management and the development of a methodological process to transform these databases into services (from data to service). In the INDECIS project, a co-creation methodology for tourism services (Font et al 2021) was developed. By engaging stakeholders in the process, IURESCAT/C3 ensured that the resulting services would be relevant and aligned with the demands of the target audience.

Since 2005 **ETS Srl has improved its engineering services and has offered high-quality innovative solutions**. They are related to railway and road design, environmental and territorial design. Multidisciplinary team talent is supported by cutting-edge solutions, technologies and Project Management processes. This association makes it possible to manage every single phase of the project in a linear and meticulous way: analysis, planning, design and delivery. Thanks to this accurate process, it is possible to reach new standards in terms of quality, value, respect of deadlines and cost savings.

PROJECT OBJECTIVES

1. Co-Creation of risk indices.
2. Enhancement of Risk Management Services: Improve ETS' existing risk management services, specifically MIRET (Management and Identification of the Risk for Existing Tunnels) and MIRETS (Management and Identification of the Risk – ETS).
3. Future Scenario Consideration: Enable consideration of different future scenarios based on Representative Concentration Pathways (RCPs) to assess infrastructure vulnerability and give information to plan adaptation and mitigation actions.
4. User-Centric Approach: Gather user feedback and engagement to meet their specific needs and address their concerns.
5. Value Addition to ETS Management Systems: Provide added value to ETS' management systems.

METHODOLOGY AND OUTCOMES

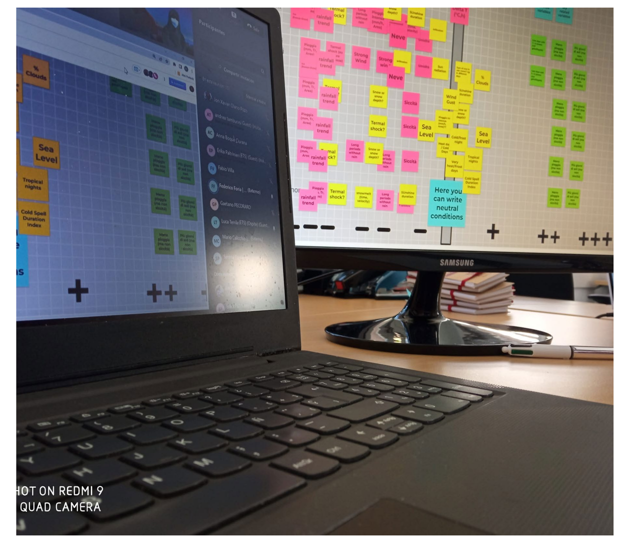
1. Stakeholder Engagement

Technical people, managers, and other type of stakeholders were engaged to participate in workshops

2. Co-Creation Workshops

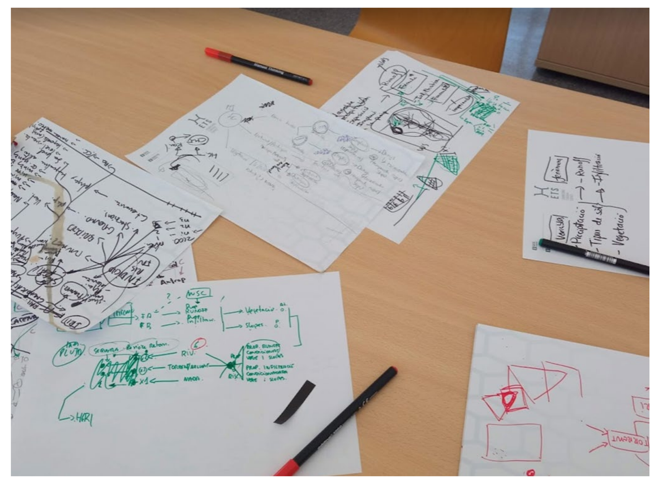
These workshops are collaborative sessions designed to bring together stakeholders to generate ideas, solve problems, and make decisions collectively. Following the methodology defined by Font et al. 2021, three steps were developed:

1. Definition of topic and diagnoses: In this step, participants identify and define the topic or problem that will be the focus of the co-creation workshop.
2. Climate and meteorological impacts on railway infrastructure elements: Once the topic is defined, participants delve into understanding the specific climate and meteorological impacts on railway infrastructure elements
3. Solutions and decisions: With the information gathered in the previous steps, participants move on to generating potential solutions and making decisions



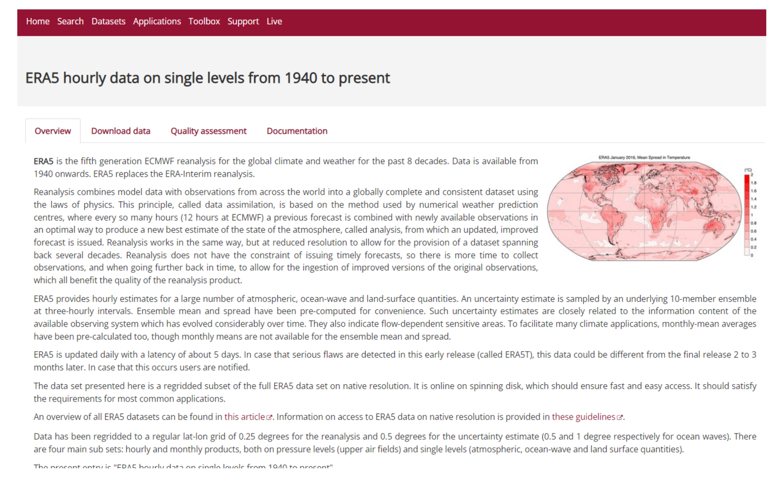
3, Indices Theoretical definition

The information obtained in the workshops is operationalized for computation with climatic data. Operationalizing the information involves converting the data and knowledge acquired during the workshops for decision-making and planning adaptation measures.



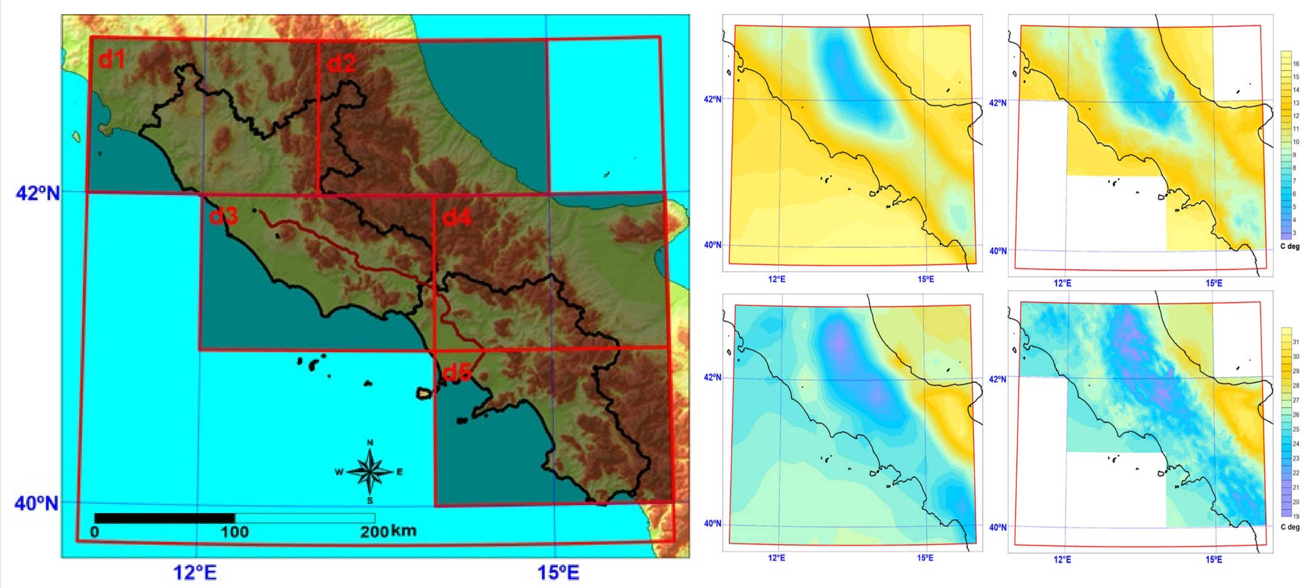
4. Data compilation

To gather the required data for the analysis, the ERA5 and ERA5 Land reanalysis models are utilized. These models provide comprehensive and high-quality climate data on a global scale. In addition to the reanalysis models, data from ETS's own stations are sought and identified. These stations likely comprise a network of weather monitoring stations or sensors maintained by ETS



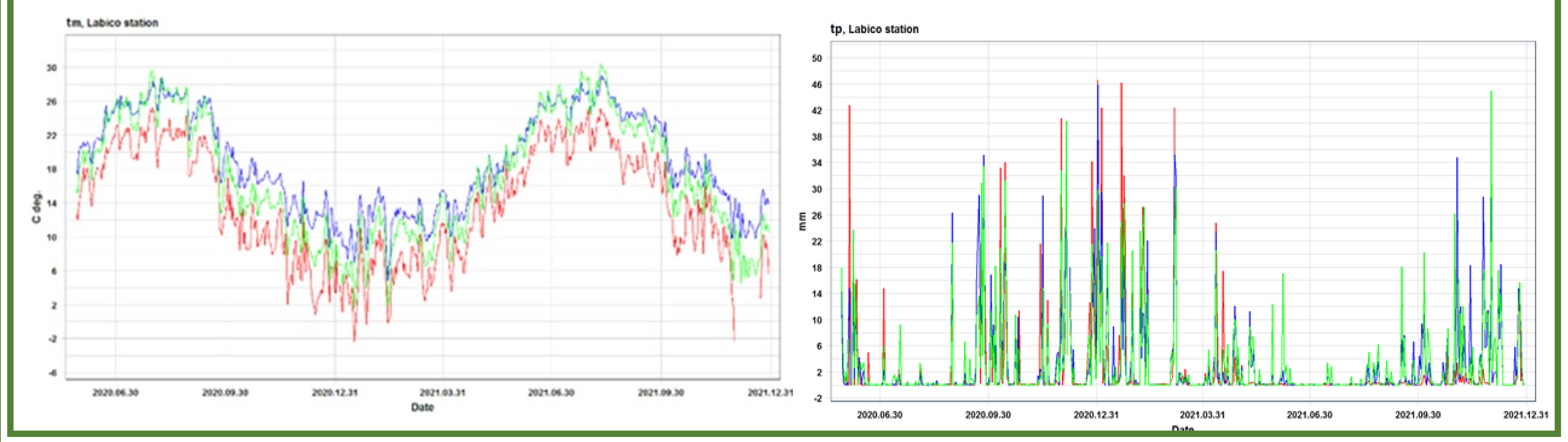
5. Downscaling

The initial data used are from the ERA5 global reanalysis with hourly time resolution and 0.25 degrees by 0.25 degrees spatial resolution, but downscaling is necessary for improved accuracy. The MISH interpolation software is employed, combining deterministic algorithms and geospatial statistical modeling. It utilizes various deterministic predictors, such as terrain elevation, AURELHY principal components, distance to the coastline, and surface roughness, to establish statistical dependencies between climate parameters and supplementary predictors. The downscaling is conducted on 0.02 degrees by 0.02 degrees (~2km by 2km) grid. The MISH modeling part is performed for the entire domain, while the interpolation is executed for five non-overlapping subdomains. This downscaling procedure generates high-resolution climate modeling for the study area.



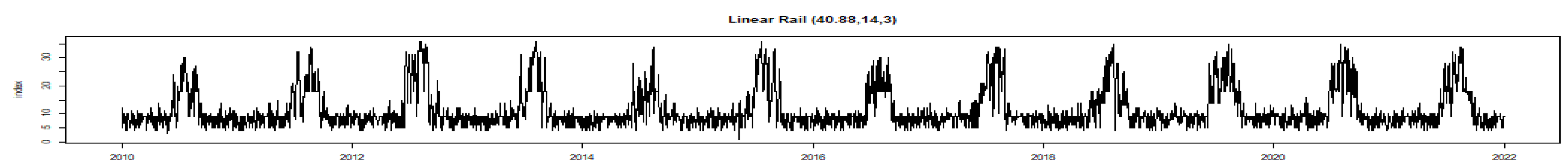
6. Validation

The downscaled data is validated, and shows improved accuracy compared to the original ERA5 data. This downscaled climate model enhances the assessment of infrastructure risk in the study area, considering various factors and climatic conditions.



7. Indices Compilation and visualization

A specific code is developed using the R software. Additionally, a Shiny application, programmed by the IURESCAT/C3 researchers, is utilized for visualizing the results. This integrated approach allows for comprehensive analysis and informed decision-making and risk management.



8. Integration in MIRETS Module

The final part of the project involves integrating the Climatic Module into the MIRET and MIRETS frameworks. The MIRET and MIRETS frameworks gain enhanced capabilities for considering climate-related factors and their impact on infrastructure performance and resilience. This integration allows for a more comprehensive evaluation of infrastructure risk, enabling stakeholders to make informed decisions and implement appropriate adaptation measures to mitigate the potential effects of climatic conditions on the train line

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