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A stress-test framework for evaluating the impact of low probability, extreme natural hazards on critical European transport infrastructure networks: The INFRARISK project

María José Jiménez (1), Eugene O' Brien (2), and the INFRARISK Consortium Team
(1) CSIC, MNCN, Spain (mj.jimenez@csic.es), (2) ROD, Dublin, Ireland (eugene.obrien@rod.ie)

Extreme natural hazard events have the potential to cause significant disruption to critical infrastructure (CI) networks. The EU-funded INFRARISK FP7 project aimed to develop a reliable stress test framework to evaluate the impact of low probability, extreme natural hazards on critical transport infrastructures networks.

The efforts of INFRARISK have focussed on developing an operational analysis framework, which considers extreme hazards and their cascading effects, with the impacts on CI transport networks, while considering their geospatial vulnerabilities. The project is providing practical software tools to infrastructure owners and managers, as well as guidelines and training activities. The systematic application of the proposed stress test framework is demonstrated through the simulation of European road and rail case studies.

The INFRARISK Decision Support Tool (IDST) is an advanced information system that enables civil engineers, infrastructure maintenance agencies and crisis managers to assess the potential risks due to natural hazards and their associated cascading effects. The hazards considered include earthquakes and floods, as well as their cascading landslide effects. The IDST hosts specialised databases with supporting scenario simulations for natural hazards and their likelihood of occurrence in relation to CI. Data analytics modules are also supported, providing geographically-mapped infrastructure vulnerabilities, in terms of structural damage and functionality loss for CI networks. The IDST is a Web-enabled system portal, which is accessible via a user-friendly web browser under multiple client platforms (laptop, tablet, etc.) and operating systems (Windows, Linux, etc.). A GIS Knowledge Base has also been established as part of the project, which allows users to upload, transform and query data relating to infrastructure components and natural disaster events. The target users of this Knowledge Base are infrastructure managers. In addition, researchers are potential users (risk management, transportation, civil engineering, natural sciences, etc.), who would benefit significantly from this extensive database.

The methodological core of the approach is based on the establishment of an 'overarching methodology' to evaluate the risks associated with multiple infrastructure networks for various hazards with spatial and temporal correlation. In its implementation for a road network, the risk is evaluated due to extreme earthquake hazard scenarios and the associated cascading effects in terms of earthquake-triggered landslides. The seismic vulnerability of the identified bridges and tunnels is considered, as well as the vulnerability of road sections to earthquake-triggered landslides. The direct consequences to the network are analysed in terms of physical damage to the network elements. In addition, the indirect consequences to the region are analysed in terms of the additional travel times encountered by road users and the associated economic losses.

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