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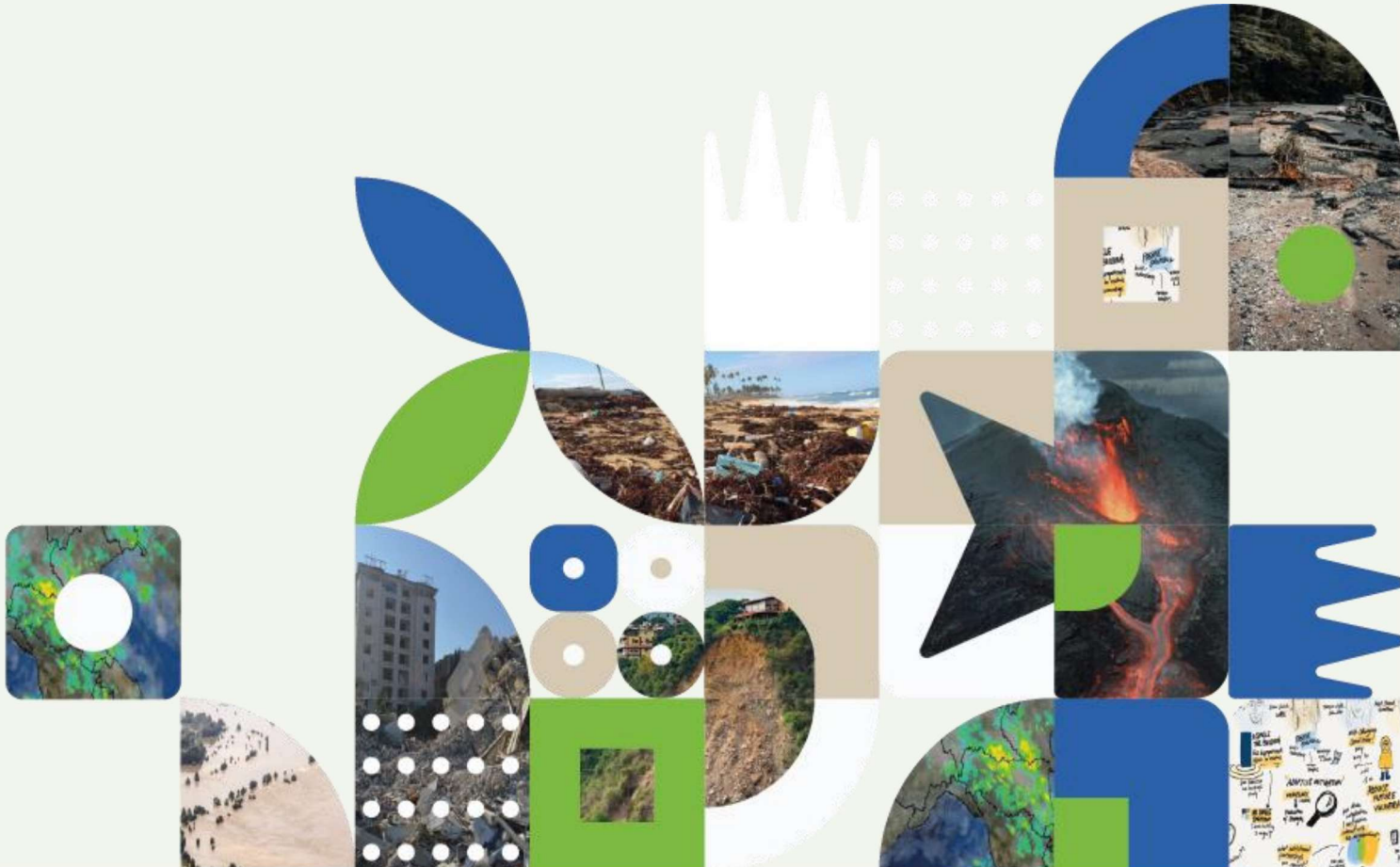
Torino (Italy), 1-2 February 2024

BOOK OF ABSTRACTS



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Spatial vulnerability characterization between industrial infrastructure and territory using a multi-hazard, multi-scale approach

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Climate change trends could significantly increase annual damage to critical infrastructure in Europe by the end of the century, with industry being among the sectors with potential higher losses (Stoerk et al., 2018). In this regard, the European Commission has issued Directive 2022/2557 on the resilience of critical entities, by requiring Member States to identify and assess their risks, emphasizing to consider all relevant natural and man-made hazards that might result in incidents. Directive 2022/2557 stipulates that Member States must consider relevant risk assessments in compliance with sector-specific Union legislation, with explicit mention of Directive 2012/18/EU (Seveso III). Therefore, it demonstrates that at least a subset of macro-sectors belonging to the Major Hazards Industries (MHI) are considered critical entities.

In parallel, the MHI represents a source of threats to the territorial context where the plants are located, which coupled with other hazards, present unique risks to the communities and the environment. However, the current Land Use Planning (LUP) around MHI is only determined by the damage areas estimated in technological risk assessments, considering just the external vulnerable elements that could be impacted in case of an industrial accident. Conversely, the opposite direction where process plants are potential targets of the complex interaction of natural and territorial hazards, is often missed or overlooked, failing to address concomitant risks that could arise on the same territory in a bidirectional sense (Pilone et al., 2021). From this gap, a research question arises: can Major Hazard Industries (HIs) be characterized at different scales through a multi-hazard approach to detect vulnerability signals relevant to their surrounding territories? Then, the purpose of this research is to systematically characterize MHI from a multi-hazard approach to detect vulnerability signals. A downscaling was carried out in the Italian context being a representative study case as one of the countries with the largest number of Seveso plants. Space-dependent analyses were developed using open data and geographical information systems (GIS). Part of the methodology used in this work was generated under the activities of the Responsible Risk Resilience Center (R3C) of Polito.

First, from the available information obtained from national inventories (ISPRA, 2021), the Major Hazard Industries were clustered into the principal industrial macro-sectors defined in Ricci et al. (2021) and represented at a regional scale linking their distribution to meteorological data of interest. Second, at the regional scale selecting the Piedmont Region, the MHI were represented as punctual infrastructures, applying diverse threshold categories according to the LUP criteria in the national and regional legal framework. Subsequently, the population involved inside the different buffer zones in case of an accident was estimated in each province, considering the intersection between the so-called exclusion or observation areas, with the average population density (persons by hectare obtained from the National Institute of Statistics- ISTAT) (Castro Rodriguez et al., 2022). Third, at the municipal scale, a multi-hazard GIS-based tool was applied with a focus on the industrial context (a portion of territory inside and outside the plant boundaries), aiming to characterize vulnerability scenarios considering the bidirectional interaction between industry and territory (Castro Rodriguez et al., 2023). A hypothetical industrial plant was used as case study with elements from the real world to simulate scenarios.

Overall, this systematic and comprehensive approach delivers a spatial vulnerability profile between MHI and their surrounding territories. It aids in identifying signals that merit further correlation with insights gained

from historical analyses on Natech impacting industrial infrastructure, across different natural hazards. Moreover, increase the awareness of stakeholders at different scales improving the decision-making process.

Water treatment plants are a recognized critical section within industrial plants, particularly the MHIs. They are vulnerable to intensive atmospheric phenomena, in particular heavy rains. From this the collaboration with the Università degli Studi di Palermo, to specifically address the issue of water treatment and to extend the developed approach to the civil water treatment plants (drinking and wastewater) at large. Heavy rains may cause geomorphological and hydraulic hazards that could affect the operation of drinking and wastewater TP. The PAI maps were used to assess these hazards. In addition, geolocalization of assets of interest, as punctual elements (DWTP and WWTP), was carried out using geographical information systems.

These topics are investigated within the RETURN project. Specifically, within the Spoke TS2-Multi Risk Resilience of Critical Infrastructures. WP 3 - Dynamic mapping of natural and climatic hazards over the infrastructure systems. T 3.2 – Robust hazard mapping over point critical infrastructures. Sub Task 3.2.2. Natural Hazards classification maps of point-like infrastructures of national relevance.
The synthesis of the principal results is represented in Figure 1.

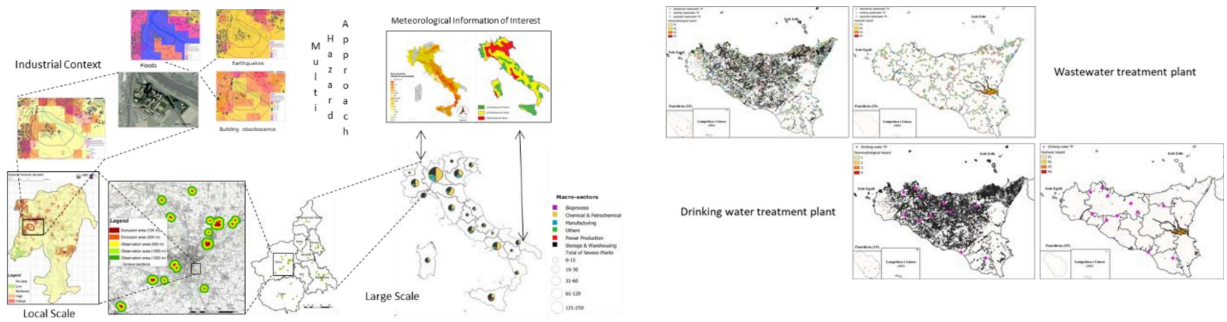

Figure 1 – Results from the multi-hazard, multi-scale approach depicting vulnerability between Industry and Territory.

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