Spatial vulnerability characterization in case of mutual impact of industrial infrastructure and territory

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Abstract

The European Commission has issued Directive 2022/2557 to address the potential impact of climate change on critical infrastructure in Europe. There is an explicit necessity to integrate risk evaluations between the current Seveso III directive (2012/18/EU) and the future (EU) 2022/2557 transposed directive. This integration aims to strengthen the resilience of critical industrial entities that are at risk from multiple hazards in their surrounding territory, including steps to identify their vulnerabilities. However, neither explicit instructions nor methodologies are included in the referred legal text about how vulnerabilities should be handled. The Major Hazards Industries (MHIs) represent a source of threats to the territorial context where they are located, which, coupled with other hazards become unique risks. However, the current Land Use Planning (LUP) around MHI often overlooks when process plants are potential targets of the complex interaction of natural and territorial hazards. This research aims to systematically characterize the vulnerability of MHIs within multi-hazard frameworks using a multi-scale spatial approach. A downscaling was carried out in the Italian context as a case study, where space-dependent analyses were developed using open data and geographical information systems (GIS). Using national inventory MHIs were clustered in industrial macro-sectors, and represented at a national scale by regions, linking their distribution to meteorological data. At the regional scale, the MHI of the Piedmont Region was represented as punctual infrastructure. The population inside buffer zones for accidents was estimated in each province, considering intersections between exclusion or observation areas and average population density. At the municipal scale, a multi-hazard GIS-based tool for vulnerability assessment was tailored to a reduced scale focus on industrial context to characterize vulnerable scenarios considering the bidirectional interaction between industry and territory. This vulnerability baseline, represents a proof of concept laying the groundwork for the Safety Study Integrated of Area (SSIA) proposed in the Italian transposition for Seveso III, in areas prone to major industrial hazards. A critical energy infrastructure was used to represent elements from the real world and simulate scenarios. Overall, this systematic and comprehensive approach delivers a spatial vulnerability profile between MHIs and their surrounding territories at different scales. It aids in identifying signals that merit further correlation with insights gained from historical records on Natech across different natural hazards. This approach contributes to increasing the awareness of stakeholders not only at different levels but also with different interests within the decision-making process, from operators to competent authorities.

Keywords: Geographical Information Systems (GIS), Multi-hazard, NaTech, Major Hazards Industries, Vulnerability