

A new holistic approach to vulnerability assessment to natural hazards of socio-economic systems by means of Graph Theory

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In the last years, the relations and interactions between multi-hazards, vulnerability, exposure and resilience spheres are assuming more and more attention and the scientific community recognized that they are very dynamic, complex and interconnected.

The traditional approaches define risk as the potential economic, social and environmental consequences due to a hazardous phenomenon in a specific period. Although there have been major improvements in recent years, there are still some limitation in term of a holistic approach that is able to include the emergent value hidden in the relation and interaction between the different spheres. Furthermore, the emergent behaviour of a society makes the collective risk greater than the sum of the parts and this requires a holistic, systematic and integrated approach. For this reason, it is important to consider the connections between elements to assess properly the vulnerability of systems. In a system (e.g. road, hospital and ecological network, etc.), or in a System of System (e.g. socio-technical urban service), there are critical elements that, beyond the intrinsic vulnerability, can be characterize by greater or lower vulnerability because of their physical, geographical, cyber or logical connections. To understand the system response to a perturbation, and therefore its resilience, is necessary not only to represent but also to quantify the relative importance of the elements and their interconnections.

To this aim, we propose an innovative approach in the field of natural risk assessment based on the properties of graph $G=(N,L)$. A graph consists of two sets N (nodes) and L (links): the nodes represent the single exposed elements (physical, social, environmental, etc.) to a hazard, while the links (or connections) represent the interaction between the elements. This approach encourages the risk assessments to a new prospective: from reductionist to holistic. The final goal is to provide insight in understanding how to quantify integrated collective vulnerability, resilience and risk.