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Comparison of a traditional with a new approach based on Graph Theory to vulnerability assessment to natural hazards: a study case on a socio-economic complex system

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The emergent behaviour of the contemporary complex, socio-technical and interconnected society makes the collective risk greater than the sum of the parts and this requires a holistic, systematic and integrated approach. 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 connections between exposed elements and the interactions between the different spheres of the multi-hazards, vulnerability, exposure and resilience.
To deal with these challenges it is necessary to consider the connections between the exposed elements (e.g. populations, schools, hospital, etc.) and to quantify the relative importance of the elements and their interconnections (e.g. the need of injured people to go to hospital or children to school). 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 characterized by greater or lower vulnerability because of their physical, geographical, cyber or logical connections.
To this aim, we propose in this study a comparative analysis between traditional reductionist approach and a new holistic approach to vulnerability assessment to natural hazards. The analysis considers a study case of a socio-economic complex system through an innovative approach 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. The final goal is to illustrate an application of this innovative approach of integrated collective vulnerability assessment.