Geophysical Research Abstracts
Vol. 20, EGU2018-18451, 2018
EGU General Assembly 2018

The use of Graph Theory to improve disaster risk assessment

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In the last years, scientists and practitioners recognize the complexity of the risk assessment system and interactions within it. In today's complex socio-technological society, traditional risks (hazard, vulnerability and exposure) and exposed elements are strongly linked.
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. 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.
These complex interactions require a shift in paradigm from a reductionist to a holistic risk assessment approach and model. To support and promote this change, a Graph Theory perspective will be presented, focusing on a reflection on graph properties and risk components. The hazard intensity variable is identified by the fraction of hit nodes among all the nodes making up the network. The propensity of a node to be isolated (vulnerability proxy) is represented by its closeness, betweenness and the degree of distribution of the network. The relative importance of the nodes (exposure proxy) can be investigated through authority analysis, and the percolation threshold (pc) is proposed as a good proxy of network resilience.
The approach will be discussed with regard to its potential inclusion of a multi-hazard, integrated risk and cascade effect analysis. The presentation will also identifies the greatest needs and proposes areas of future development.