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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Natural hazard risk of complex systems – the whole is more than the sum of its parts: I. A holistic modelling approach based on Graph Theory" *by* Marcello Arosio et al.

Anonymous Referee #2

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Summary:

This paper only takes us about 60% of the way there. While I do think you have a novel idea of using graph theory to model risk transfer in a way that has not been done, you don't fully show us how to do it conceptually.

e.g. you explain how graphs work. and give some discussion of how these graph properties link to vulnerability, resilience, and exposure. But you need to go much further. What metrics do you propose we use from graph theory that link to which metrics in risk assessment? Maybe this is what you are trying to do with percolation but it is still very unclear. How are you going to get us towards measure cascading

risks with your new approach.

Part of the problem is the disorganized literature review and background. You are missing a lot of the resilience literature on this topic, and it feels like you are describing papers selectively. Please organize this into topics, themes, that lead to the demonstrating the gap in the lit that your new graph theory approach will allow us to fill.

This idea has a lot of promise, but needs work. The conclusion should make me feel like I have a new tool and idea to measure risk. But I am left feeling confused.

Line 45. Vulnerability does consider social conditions. That is a wrong statement

Line 59. See the work on compound flood risk. Eg. Wahl, Thomas, Shaleen Jain, Jens Bender, Steven D. Meyers, and Mark E. Luther. "Increasing risk of compound flooding from storm surge and rainfall for major US cities." Nature Climate Change 5, no. 12 (2015): 1093. Zscheischler, J., Westra, S., Hurk, B.J., Seneviratne, S.I., Ward, P.J., Pitman, A., AghaKouchak, A., Bresch, D.N., Leonard, M., Wahl, T. and Zhang, X., 2018. Future climate risk from compound events. Nature Climate Change, p.1.

Line 80. Great examples. Surprise to see lack of citatations for the large literature on compounding risk and cascading failtures from the resilience field. E.g.

Buldyrev, S. V., Parshani, R., Paul, G., Stanley, H. E., & Havlin, S. (2010). Catastrophic cascade of failures in interdependent networks. Nature, 464(7291), 1025. Chicago Line 84. I have never heard of this rinaldi paper. I doubt it is the most quoted.

In general this literature review feels selective and disorganized. Use subheadings. What is the gap you are filling? Are you really the only/first people to use graph theory to assess risk. I somehow doubt it. A simple google scholar search revealed many articles:

Heckmann, T., Schwanghart, W., & Phillips, J. D. (2015). Graph theoryâĂŤRecent developments of its application in geomorphology. Geomorphology, 243, 130-146. Holmgren, Åke J. "Using graph models to analyze the vulnerability of electric power

networks." Risk analysis 26, no. 4 (2006): 955-969. Lhomme, S., Serre, D., Diab, Y., & Laganier, R. (2013). Analyzing resilience of urban networks: a preliminary step towards more flood resilient cities. Natural hazards and earth system sciences, 13(2), 221-230.

Also see risk transfer analysis 1. Sapountzaki, K. Social resilience to environmental risks: A mechanism of vulnerability transfer? Manag. Environ. Qual. An Int. J. 18, 274–297 (2007).

Page 165. Its hard to read all your definitions in prose. Made a table or a diagram that shows in a depiction each term. Add more to figure 1.

Line 196. What is pc. What is k.

Line 265. It is not until here that you tell me what graph theory contributes to vulnerability analysis. WHY is current risk analysis lacking and WHAT does graphs uniquely help us understand.

330. I have never heard of this definition of resilience. This need to be motivated by the enourmous literature on the topic to some degree.

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