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Floods-triggered cascading effects of interdependent infrastructure networks.

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Floods are one of the most damaging natural hazards and cause disruption of infrastructure networks, as road and rail networks. Understanding the behavior of infrastructure networks when subject to floods is crucial in minimizing disruption and enhancing flood risk management strategies. Recently, a network science approach was used for modelling the infrastructure networks disruptions due to flooding events (Kermanshah & Derrible, 2017; Pregnolato et al., 2016; Wang et al., 2018). In the current study, we adopt a multi-layer approach in order to characterize interdependency in the specific case of the Swiss transport infrastructure networks. Both the Swiss road and rail networks are represented by different layers coupled at train stations. In interdependent networks, it is known in general (Buldyrev et al., 2010) that the failure of one network may affect the failure of the second network in a recursive process, leading to a cascade of failures and eventually to the failure of the whole system. Cascading effects are triggered by flooding events, which are simulated with a physical modelling framework, including meteorological, hydrological and inundation models, as presented by Zischg et al. (2018). The goal of this study is to uncover the resilience and robustness in the real-world case of the Swiss transportation system during flooding events, identifying the system weaknesses and providing elements for policy makers and engineers. The usage of the theoretical framework of multi-layer networks in addressing a specific applied case is discussed, and the wide-spreaded disruption effects on the Swiss transportation system, due to localised extreme precipitation events, are shown.

Buldyrev, S. V., Parshani, R., Paul, G., Stanley, H. E., & Havlin, S. (2010). Catastrophic cascade of failures in interdependent networks. Nature, 464, 1025. doi:10.1038/nature08932

Kermanshah, A., & Derrible, S. (2017). Robustness of road systems to extreme flooding: using elements of GIS, travel demand, and network science. Natural Hazards, 86(1), 151-164. doi:10.1007/s11069-016-2678-1

Pregnolato, M., Ford, A., Robson, C., Glenis, V., Barr, S., & Dawson, R. (2016). Assessing urban strategies for reducing the impacts of extreme weather on infrastructure networks. Royal Society open science, 3(5), 160023-160023. doi:10.1098/rsos.160023

Wang, W., Yang, S., Hu, F., Stanley, H. E., He, S., & Shi, M. (2018). An approach for cascading effects within critical infrastructure systems. Physica A: Statistical Mechanics and its Applications, 510, 164-177. doi:https://doi.org/10.1016/j.physa.2018.06.129

Zischg, A. P., Felder, G., Weingartner, R., Quinn, N., Coxon, G., Neal, J., . . . Bates, P. (2018). Effects of variability in probable maximum precipitation patterns on flood losses. Hydrol. Earth Syst. Sci., 22(5), 1607–7938.