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On the nexus between critical transport infrastructure and society – landslide vulnerability assessment of road networks in a rural alpine area

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Strategic transport infrastructure networks are complex and interconnected systems that are vital from local to global scales. Any sudden disruption can result in debilitating impacts on human life, the economy and the society as a whole. Interruptions of the transport flow may lead to potentially severe consequences in terms of both direct and indirect losses, since the system does not feature redundant elements at comparable economic efficiency. Therefore, the assessment of vulnerability and exposure of critical transport infrastructure in alpine regions is of great importance for guaranteeing the smooth functioning of societies in these particularly risk-prone areas.

Among various natural and man-made hazards, landslides emerge as particularly disastrous events jeopardizing the integrity of land transport systems by causing structural damage and network interruptions. Based on an in-depth analysis of a selected region in Austria (Vorarlberg) we present a data-driven vulnerability assessment framework (which is specifically targeted at landslides events) for critical infrastructures as well as communities and societies.

By taking into account derivates of a high-resolution digital terrain model as well as geological properties, a probabilistic landslide susceptibility map of the test region is derived by applying the weight of evidence method. This susceptibility map, concatenated with historic data of landslide inventories and a digital road graph, allows to identify critical sections of the road network.

Effects of interruptions of the road network at these critical sections are analyzed by applying a mesoscopic multi-agent transport simulation model. By employing a utility function for the agent-based traffic model, the effects of transport network interruptions on the population in the test region are reported as generalized costs (i.e. monetary costs, time losses, etc.).

This study supports the proactive development of adaptation strategies towards landslides in risk-prone areas as well as the realization of cost-efficient and effective protection measures.