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Assessing trends in future exposure and vulnerability of population to natural hazards based on tacit knowledge and data mining techniques

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Disaster risk is defined as the potential losses of lives, livelihoods, assets, and the adverse effects on human health due to the dynamic interactions of natural hazards with the socioeconomic sphere, i.e. conditions of exposure and vulnerability. Disaster risk is hence a combination of hazard intensity, exposed elements at risk such as people or assets, and their vulnerability. These interactions are particularly complex in cities as focal points of population, economic activity, and innovation.

Due to the forward-looking nature of disaster risk, effective disaster risk reduction requires knowledge on both the current and the future conditions regarding the aforementioned disaster risk components. The latter includes knowledge on changes in hazard severity, intensity and frequency on the one hand, and on the other, knowledge on trends in exposed economic, social or environmental elements at risk and corresponding vulnerabilities. To estimate these future socioeconomic conditions, particularly at micro-scale, it is of paramount importance to understand the processes that drive exposure and vulnerability at local level. Residential housing choice is such a complex process.

Residential housing choice shapes the spatial exposure of urban population towards natural hazards. It is underpinned by housing market demand and restrictions, but also driven to a large extent by individual preferences, which constitute partly explicit and partly tacit knowledge. Understanding these preferences allows identifying urban neighbourhoods with high potential for population growth—and consequently an increase of exposure—as a function of their attractiveness. Gaining insights into the housing choice preferences of different socioeconomic and demographic groups, i.e. preference heterogeneity, will further help to build an understanding of how vulnerability is likely affected by this process.

This study, for the application case of the city of Leipzig, Germany, combines a knowledge elicitation approach for tapping into different bodies of knowledge with data mining techniques, e.g., random forests, to identify and predict heterogeneous housing choice preferences based on various explanatory variables such as city district or proximity to urban green infrastructure. This prediction model is then translated into a spatial perspective on residential housing choice, which subsequently allows determining spatial hotspots of change as well as trends in exposure and vulnerability towards natural hazards such as flooding and urban heat. In so doing, urban planning is assisted in its objectives, firstly, to manage urban growth and urban development to meet societal demands, and secondly, to reduce disaster risk by identifying those areas where the implementation of adaptive measures will likely be needed most urgently.