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Collaborative development of land use change scenarios for analysing hydro-meteorological risk

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Simulating future land use changes remains a difficult task, due to uncontrollable and uncertain driving forces of change. Scenario development emerged as a tool to address these limitations. Scenarios offer the exploration of possible futures and environmental consequences, and enable the analysis of possible decisions. Therefore, there is increasing interest of both decision makers and researchers to apply scenarios when studying future land use changes and their consequences. The uncertainties related to generating land use change scenarios are among others defined by the accuracy of data, identification and quantification of driving forces, and the relation between expected future changes and the corresponding spatial pattern. To address the issue of data and intangible driving forces, several studies have applied collaborative, participatory techniques when developing future scenarios. The involvement of stakeholders can lead to incorporating a broader spectrum of professional values and experience. Moreover, stakeholders can help to provide missing data, improve detail, uncover mistakes, and offer alternatives. Thus, collaborative scenarios can be considered as more reliable and relevant. Collaborative scenario development has been applied to study a variety of issues in environmental sciences on different spatial and temporal scales. Still, these participatory approaches are rarely spatially explicit, making them difficult to apply when analysing changes to hydro-meteorological risk on a local scale. Spatial explicitness is needed to identify potentially critical areas of land use change, leading to locations where the risk might increase. In order to allocate collaboratively developed scenarios of land change, we combined participatory modeling with geosimulation in a multi-step scenario generation framework. We propose a framework able to develop scenarios that are plausible, can overcome data inaccessibility, address intangible and external driving forces of land change, and is transferable to other case study areas with different land use change processes and consequences. The framework starts with the involvement of stakeholders where driving forces of land use change are being studied by performing interviews and group discussions. In order to bridge the gap between qualitative methods and conventional geospatial techniques, we applied cognitive mapping and the Drivers-Pressures-State-Impact and Response framework (DPSIR) to develop a conceptual land use change model. This was later transformed into a spatially explicit land use change model based on remote sensing data, GIS and cellular automata spatial allocation. The methodology was developed and applied in a study area in the eastern Italian Alps, where the uncertainties regarding future urban expansion are high. Later, we transferred it to a study area in the Romanian Carpathians, where the identified prevailing process of land use change is deforestation. Both areas are subject to hydro-meteorological risk, posing a need for the analysis of the possible future spatial pattern and locations of land use change. The resulting scenarios enabled us, to point at identifying hot-spots of land use change, serving as a possible input for a risk assessment.