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# Spatial vulnerability assessments by regression kriging

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Two fairly different complex environmental phenomena, causing natural hazard were mapped based on a combined spatial inference approach. The behaviour is related to various environmental factors and the applied approach enables the inclusion of several, spatially exhaustive auxiliary variables that are available for mapping.

Inland excess water (IEW) is an interrelated natural and human induced phenomenon causes several problems in the flat-land regions of Hungary, which cover nearly half of the country. The term 'inland excess water' refers to the occurrence of inundations outside the flood levee that originate from sources differing from flood overflow, it is surplus surface water forming due to the lack of runoff, insufficient absorption capability of soil or the upwelling of groundwater. There is a multiplicity of definitions, which indicate the complexity of processes that govern this phenomenon. Most of the definitions have a common part, namely, that inland excess water is temporary water inundation that occurs in flat-lands due to both precipitation and groundwater emerging on the surface as substantial sources.

Radon gas is produced in the radioactive decay chain of uranium, which is an element that is naturally present in soils. Radon is transported mainly by diffusion and convection mechanisms through the soil depending mainly on soil physical and meteorological parameters and can enter and accumulate in the buildings. Health risk originating from indoor radon concentration attributed to natural factors is characterized by geogenic radon potential (GRP). In addition to geology and meteorology, physical soil properties play significant role in the determination of GRP.

Identification of areas with high risk requires spatial modelling, that is mapping of specific natural hazards. In both cases external environmental factors determine the behaviour of the target process (occurrence/frequncy of IEW and grade of GRP respectively). Spatial auxiliary information representing IEW or GRP forming environmental factors were taken into account to support the spatial inference of the locally experienced IEW frequency and measured GRP values respectively. An efficient spatial prediction methodology was applied to construct reliable maps, namely regression kriging (RK) using spatially exhaustive auxiliary data on soil, geology, topography, land use and climate. RK divides the spatial inference into two parts. Firstly the deterministic component of the target variable is determined by a regression model. The residuals of the multiple linear regression analysis represent the spatially varying but dependent stochastic component, which are interpolated by kriging. The final map is the sum of the two component predictions.

Application of RK also provides the possibility of inherent accuracy assessment. The resulting maps are characterized by global and local measures of its accuracy. Additionally the method enables interval estimation for spatial extension of the areas of predefined risk categories. All of these outputs provide useful contribution to spatial planning, action planning and decision making.

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