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A GIS approach to risk analysis in the city of Tuzla (BiH) after severe ground deformation phenomena

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Ground deformation phenomena affecting the town of Tuzla (Bosnia Herzegovina) began more than 50 years ago. The severe exploitation of underground salt deposits by means of boreholes and mines induced several hazard factors such as ground subsidence, deep and shallow fracturing, intense groundwater table oscillations.
Previous studies analyzed the historical database of topographic and piezometric data, showing more than 12 meters of cumulative subsidence as consequence of wild brine pumping, and water table rises in the range of 20-80 meters after the withdrawal reduction. Fractures arose as obvious result of ground deformation and caused damages and demolitions to thousands of buildings. Data have been investigated and correlated using geographical information systems and multicriteria decision analysis, that defined a risk map of the area highlighting the most threaten districts of the town. As result, the flooding hazard looks to be the main actual problem, as consequence of the intense water table rises that affect the most sunk area of the town. A recent paper analyses data obtained by means of GPS, leveling surveys and piezometric soundings, evidencing a trend inversion in the surface vertical movements whereas groundwater table presents significant rises.
In this work a new hazard factor has been added to the risk calculation procedure, while previous hazards have been updated and recalculated in order to obtain an average annual rate. In particular a detailed digital elevation model of Tuzla area has been processed in a GIS structure to calculate the flow accumulation and the stream network of surface waters. That allows the identification of most prone flooding areas from surface inputs, and identifies a new hazard factor to be considered in the overall risk assessment. The multicriteria analysis has been used to combine various hazard factors and started the risk analysis based upon the assessment of exposure and vulnerability in the geographical approach.
In particular the contribution of exposure to the risk assessment has been improved by the implementation of cadastral construction tax, whereas the vulnerability term has been processed after the availability of GIS data related to infrastructure, technological networks and presence of public/private utilities. By using the classical Varnes (1984) approach to risk evaluation a final risk map has been produced over the investigated area and several weaknesses detected and addressed.