



Recent geodetic surveys and multi-hazards assessment in the sinking town of Tuzla (BiH)

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Ground subsidence triggered by salt mining from deposits located beneath the city of Tuzla (Bosnia & Herzegovina) is one of the major danger acting on a very densely urbanized area since 1950, when the salt deposits exploitation by means of boreholes began. As demonstrated in previous work, subsidence induced several hazard factors such as a severe ground deformations, the arising of deep and superficial fractures and a very fast water table rise connected with the brine extraction.

In the past, hazard's factors were investigated by the processing of a series of data collected during two periods; from 1956 to the 1991, and from 1992 to 2003 whereas more recent sinking and deformation rates are being investigated by the use of geomatic methodologies and analysis of geographical data. The analysis of the historical dataset revealed a cumulative subsidence as high as 12 meters during the whole period, causing damage to buildings and infrastructures within an area that includes a large portion of the historical town, nowadays almost entirely destroyed. In previous work all the hazards affecting the city of Tuzla have been quantified and a map reporting the overall risk produced using the GIS (Geographical Information System) tools and a Multicriteria Decision Analysis (MDA). The MDA highlighted a serious risk due to the present-day water table rise, triggered by the decreasing in brine pumping in well defined portion of the city, not necessarily involved in the most severe ground deformations. For such reason since 2004 new elevation data were attained by six-monthly spirit levelling campaigns and more diffuse annual static GPS surveys. Results provided by geodetic surveys have been compared with the raising piezometric level and results are surprising. Both GPS survey and spirit levelling reveal a gradual inversion of sinking rates which are proceeding from negative to positive values over a great portion of the investigated area. Moreover, the impressive negative rates which were historically recorded in the most sinking area (up to -40cm/yr) are now decreasing to relatively less significant values (about -10 cm/yr). Uplift phenomena are proven to be closely related to the fast raising water table and hydrogeological mechanism have to be investigated more deeply in order to reduce the risk of flooding, in portions of the city, due to a reduced draining capability or emerging water table.