Geophysical Research Abstracts
Vol. 14, EGU2012-9881, 2012
EGU General Assembly 2012

Correlation between elevation change and groundwater level following the termination of salt exploitation in the city 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 dangerous factor 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 deformation, the arising of deep and superficial fractures and very fast water table fluctuations depending on the net amount of brine extraction.
The historical ground deformation rates have been investigated by means of traditional geodetic surveys carried out within two periods. The first leg spans from 1956 to 1991, when measurements were ceased due to the Balkans' conflict, and the second from 1996 to 2003. More recently, the monitoring of ground deformation processes is being performed by the use of novel geomatic methodologies and subsequent analysis of geospatial 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 this study we present a detailed analysis and correlation between the water table fluctuation under the city of Tuzla and recent surface deformation processes detected by close and accurate elevation surveys. The analysis highlighted a very complex spatial and temporal pattern of surface deformation. From 2006 and 2010 various stages in the deformation processes were observed in the spatial and temporal domains. The main subsidence trend show significant rates at the beginning of the time period, with gradual stabilization that, somewhere, turns to a significant ground uplift rate. This behavior seems to be strongly correlated to the water table movement that, after a reduction in the brine exploitation experienced in the first part of the mentioned period, shows a sudden rise of piezometric levels. The new hydrostatic equilibrium is now counterbalancing the sinking phenomena and the vertical displacements are nowadays ranging from -100mm/yr to +20mm/yr. Final conclusions focus on the strict relationship between the two investigated phenomena, pointing out the importance of control the water table movements to identify and prevent further ground deformations.