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Curvature analysis used to map subsidence-related hazard areas in the city of Tuzla (BiH)

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We present a novel methodology to identify areas of localized deformation in a sinking urban area. Tuzla is located in the NE part of Bosnia and Herzegovina, its subsurface contains large Miocene salt deposits. In the year 1950 a massive salt exploitation via dissolution of the salt rock by pumping of groundwater was begun. Since then, the urban area sank an average of 6.5 m over an area of about 4 sq. km causing the destruction of about 2000 buildings. The city is now faced with the problem of identifying the areas of highest risk connected to surface deformations for future urban planning. .The geological and geophysical methodologies used so far (borehole drillings, refraction seismology and geo-electric resistivity tomography) have not been successful in characterizing the subsurface structures responsible for the city sinking. Using the surface displacements data acquired from a geodetic network, we have been able to reconstruct a surface of cumulative subsidence from the year 1956 to 2003. Given that the major damage to buildings and infrastructure has been focused in areas of strain localization (surface fractures and faults), we used surface attributes to identify them. The surface attributes used are the directional, gaussian and normal curvatures computed from the cumulative subsidence surface. We compared maps of faults and fractures exposed at the surface to the curvature maps obtained with the previously mentioned methods. As a general observation we see good correlation between the trends and the intensity of high and low curvature areas and the trends and density of faults and fractures. In particular, the directional curvature seems to be sensitive to faults and fractures exposed at the surface, whereas the gaussian and the normal curvatures better characterize deep areas of strain. Given the poor exposure of faults and fractures in the sub-urban area, (rough topography and dense vegetation), we use the correlation between curvature and strain localization, to create a risk zonation map.