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Multi-sensor technologies for analyzing sinkholes in Hamedan, west Iran

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Dissolution of the carbonate beds such as limestone, dolomite or gypsum by acidic groundwater flowing through fractures and joints in the bedrock alters land surface and enhances the development of sinkholes. Sinkhole formation causes the surface to subside or even collapse suddenly without any prior warning, leading to extensive damage and sometimes loss of life and property, in particular in urban areas. Delineating sinkholes is critical for understanding hydrological processes and mitigating geological hazards in karst areas.
The recent availability of high-resolution digital elevation models (DEM) from TanDEM-X (TDX) mission enables us to delineate and analyze geomorphologic features and landscape structures at an unprecedented level of details, in comparison to previous missions such as c-band and x-band Shuttle Radar Topography Mission (SRTM). In this study, we develop an adaptive sinkhole-delineating method based on photogrammetry techniques to detect karst sinkholes in Hamedan , west Iran, using TDX-derived DEMs. We apply automatic feature extraction using watershed algorithm in order to detect depression areas. We show that using high-resolution TDX data from different geometries and time periods we could effectively distinguish sinkholes from other depression features of the basin.
We also use interferometric synthetic aperture radar (InSAR) technique with SAR data acquired from a variety of sensors including Envisat, ALOS, TerraSAR-X and Sentinel-1 to quantify long-term subsidence in areas prone to sinkhole formation. Our results indicate that the formation of a lot of sinkholes is influenced by land subsidence, affecting the region over 100 km with the maximum rate of 4-5 cm/yr during 2003 to 2016.