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Application of GPR and microgravimetry surveys to karstic collapse studies in urban settings. Case study of Alcala de Ebro (Zaragoza)

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In June of 2007 a sudden collapse happened in Alcalá de Ebro, a small village 35 km WNW from Zaragoza (Spain). The collapse affected a street of the village, and showed a cavity 12 meters deep. The first hypothesis related the collapse with the last important flooding of the Ebro River. A surface survey of the village showed the presence of damages in floor and buildings that delimited several sinking centers generated years ago. This initial study was followed by a geophysical survey. Both permit to confirm that the collapse was related with a process of karstic solution that can be aggravated by some kinds of human activities in the village and the last river flood, the latter being factor influencing but not at the origin of karst hazard. The application of different techniques has permitted to refine the methodology to be applied in urban settings. Mapping of structures associated to karstic collapses, and the focalisation of the geophysical techniques in these zones, and the systematical application of different geophysical techniques has allowed to obtain a methodological approach in geophysical surveys. Some geophysical techniques show limitations in these settings because of the presence of voids, a lower density below the subsoil, the proximity of the water table and/or the salt content in water and soils. These features imply severe limitations to techniques related with the rigidity of the materials (seismic methods) and the conductivity of the subsoil (electric and electromagnetic methods). On the other hand, in urban areas, the presence of superficial elements that can produce interferences makes necessary equipment shielding or isolation from environmental noise. From the different techniques applied in urban settings, the best results were obtained combining

different equipments and methodologies. Although microgravimetric studies usually give the best results, with simple processing, they are time-consuming, especially if a 2-D study covering a wide area is necessary. GPR only reaches shallow depths in these settings, as it occurs with other electrical and electromagnetic techniques, but it offers the possibility to use shielded systems and to infer active processes by means of indirect indicators. The use of maps based in the correlation of gpr-features and grid maps provides a very good correlation with the results obtained with the mapping of structures associated with karstic collapse and the microgravimetry survey.