

# ***Interactive comment on “Time-lapse gravity and levelling surveys reveal mass loss and ongoing subsidence in the urban subsidence prone area of Bad Frankenhausen/Germany” by Martin Kobe et al.***

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The MS "Time-lapse gravity and levelling surveys reveal mass loss and ongoing subsidence in the urban subsidence prone area of Bad Frankenhausen/Germany" by M. Kobe et al. is suggested to analysis of high-precision time-lapse gravity survey and levelling studies which were conducted during more than four years in Bad Frankenhausen (Germany).

Karst areas occupy about 14% of the world's land and cause serious economic losses,

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which are estimated at dozens of billions dollars, set aside the physical danger. Precise gravity studies occupy an important role in the karst sinkhole localization. However, as correctly note the authors, time-lapse gravity measurements not frequently occur because their comparatively high labor intensity and high cost. Therefore, the efforts of the authors to perform such studies in urban region deserve a full support. These studies were supported by a large volume geodetic method (levelling) that, without hesitation, significantly increased the reliability of interpretation. Authors of the MS have carried out altogether 17 time-lapse gravity and 18 levelling campaigns over four years and combined these results to a local combined network. Generally speaking, it is a first attempt to quantify mass movements related to underground leaching.

Such an investigation according to the authors' opinion, needs in application of exclusively highly precise gravity meters (it is an important practical conclusion). The mean standard deviations obtained by the authors are between 1.1 and 3.6 microGal – very nice results for the urban areas. The effective results obtained by the authors indicate that time-lapse gravity survey can be successfully conducted even in urban areas producing different kinds of noise. This MS reflects a series of important and accurate investigations and could be used by engineers and scientists as a reference model.

It is known that in such precise measurements monitoring of underground water is of high importance. For this aim the global GLDAS Noah model was utilized. As an enthusiast of geophysical method integration, I welcome future possible combination of time-lapse gravity analysis with GPR and NMR surveys. Borehole cores analysis is also envisaged.

As a wish, I must note that two level (or multilevel) precise gravity survey (Eppelbaum et al., 2010) may be especially effective for the time-lapse gravity studies. Such a survey will be more sensitive to appearing of even small irregularities in the studied near-surface section.

I strongly recommend this MS for publication in the "Solid Earth".

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Reference Eppelbaum, L.V., Khesin, B.E. and Itkis, S.E., 2010. Archaeological geophysics in arid environments: Examples from Israel. *Journal of Arid Environments*, 74, No. 7, 849-860.

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