Geophysical Research Abstracts
Vol. 20, EGU2018-6546-1, 2018
EGU General Assembly 2018

An integrative geodetic-gravimetrical approach to investigate subrosion in the sinkhole area of Hamburg Flottbek – surface deformation and mass redistribution

Adelheid Weise (1), Gerald Gabriel (1), Tobias Kersten (2), Steffen Schön (2), Ludger Timmen (2), and Detlef Vogel (1)

(1) Leibniz Institute for Applied Geophysics (LIAG), Hanover, Germany (adelheid.weise@liag-hannover.de), (2) Institute of Geodesy, Leibniz University Hanover, Germany

Sinkholes are slowly to suddenly developing subsidence structures at the surface, caused by solution of rocks. Their hazard potential is large, especially in urban areas. In the joint research project SIMULTAN (Sinkhole Instability: integrated MULTi-scale monitoring and ANalysis) the investigation and surveillance of sinkhole areas by a combination of geophysical, petrophysical, geodetical and hydrological methods contributes to the development of an early warning system of instability, as well as, in combination with modeling, to an improved process understanding.

We focus on a region in the city of Hamburg where the subsidence areas Wobbe See and Flottbek Markt are located. Subsidence rates are in the order of 1 mm/a and presumably originate from solution processes related to the Othmarschen-Langenfelde Diapir.

Following an integrative geodetic-gravimetric approach, surface deformation and mass change due to subrosion are observed, likewise with the objective of surveillance of the sinkhole area. Quarterly repeated levelling and gravimetry campaigns at 8 stations (since 01/2016) provide first results. On the one hand, they indicate a trend to subsidence in the Wobbe See area, in agreement with results of GNSS measurements, and on the other hand, mainly seasonal variations of elevation differences emerge up to now around Flottbek Markt, that can be correlated with hydrology.

Can we detect potential mass changes in urban areas? This is investigated by repeated high-precision gravity measurements. The results are reproducible and significant temporal variations of gravity differences of up to 12 μGal (std. dev. $\sim\pm1$ μGal). These variations comprise hydrological induced seasonal variations as well, due to local conditions at the points, like topography and different ground sealing.

By tying the local, relative measurements to a regional reference system large-scale stability control is enabled. Regional SAPOS stations are linking the local, relative GNSS network and monitor their stability. Results of ionosphere free linear combination prove the stability of the local reference. The coordinate system ETRS89 in combination with the vertical datum DHHN2016 are the common geodetic datum for all combined geophysical approaches. As local urban conditions are challenging, new approaches like adaptive, dynamic elevation masks and extended recording periods are applied. Concerning gravity, annual absolute measurements are realized at one reference station, which supports the assumption of hydrological induced effects in the observed gravity changes.

The intended modelling and correction of the hydrological induced gravity effect allows to separate possibly masked small effects of mass redistribution due to solution and sinkhole development. In case of observable gravity change, e.g. the mass dependent gravity gradient dg/dh can indicate mass change.