Geophysical Research Abstracts
Vol. 19, EGU2017-12905, 2017
EGU General Assembly 2017

Detection and localization capability of an urban seismic sinkhole monitoring network

Dirk Becker (1), Torsten Dahm (2), Fabian Schneider (1,3)

(1) Hamburg University, Institute of Geophysics, Hamburg, Germany (dirk.becker-2@zmaw.de), (2) GFZ German Research Centre for Geosciences, Potsdam, Germany, (3) EMH Energie Messtechnik, Brackel, Germany

Microseismic events linked to underground processes in sinkhole areas might serve as precursors to larger mass dislocation or rupture events which can cause felt ground shaking or even structural damage. To identify these weak and shallow events, a sensitive local seismic monitoring network is needed. In case of an urban environment the performance of local monitoring networks is severely compromised by the high anthropogenic noise level.

We study the detection and localization capability of such a network, which is already partly installed in the urban area of the city of Hamburg, Germany, within the joint project SIMULTAN (http://www.gfz-potsdam.de/en/section/near-surface-geophysics/projects/simultan/). SIMULTAN aims to monitor a known sinkhole structure and gain a better understanding of the underlying processes. The current network consists of six surface stations installed in the basement of private houses and underground structures of a research facility (DESY - Deutsches Elektronen Synchrotron). During the started monitoring campaign since 2015, no microseismic events could be unambiguously attributed to the sinkholes.

To estimate the detection and location capability of the network, we calculate synthetic waveforms based on the location and mechanism of former events in the area. These waveforms are combined with the recorded urban seismic noise at the station sites. As detection algorithms a simple STA/LTA trigger and a more sophisticated phase detector are used. While the STA/LTA detector delivers stable results and is able to detect events with a moment magnitude as low as 0.35 at a distance of 1.3km from the source even under the present high noise conditions the phase detector is more sensitive but also less stable. It should be stressed that due to the local near surface conditions of the wave propagation the detections are generally performed on S- or surface waves and not on P-waves, which have a significantly lower amplitude.

Due to the often emergent onsets of the seismic phases of sinkhole events and the high noise conditions the localization capability of the network is assessed by a stacking approach of characteristic waveforms (STA/LTA traces) in addition to traditional estimates based on travel time uncertainties and network geometry. Also the effect of a vertical array of borehole sensors as well as a small scale surface array on the location accuracy is investigated. Due to the expected, rather low frequency character of the seismic signals arrays with a small aperture due to the required close proximity to the source exhibit considerable uncertainty in the determination of the azimuth of the incoming wavefront, but can contribute to better constrain the event location. Future borehole stations, apart from significantly reducing the detection threshold, would also significantly reduce the location uncertainty.

In addition, the synthetic data sets created for this study can also be used to better constrain the magnitudes of the microseismic events by deriving attenuation relations for the surface waves of shallow events encountered in the sinkhole environment. This work has been funded by the German 'Geotechnologien' project SIMULTAN (BMBF03G0737A).