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Seismic phenomena in GPS Precise Point Positioning results

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High-rate GNSS receivers can be a supplementary source of data for seismic activity research. It is expected, that the GNSS data processing products (displacements, accelerations, phase observables residuals changes) have significant correlation with seismic data and will allow to determine the earthquake event length, amplitude of displacements and polarization of seismic waves. To investigate those possibilities three earthquake events characterized by normal faulting mechanism were investigated. The first was Lamjung earthquake (Nepal, 2015-04-25 06:11:25 UTC, Mw 7.8), that occurred 36km east of Khudi, Nepal in 8.2 km depth. Two others occurred in central Italy on October 2016: 3km NNW of Visso (Italy, 2016-10-26 19:18:08 UTC, Mw 6.1) and 7km north of Norcia (Italy, 2016-10-30 06:40:18 UTC, Mw 6.6). Seismic data for these earthquakes were provided by the Center for Engineering Strong Motion Data (CESMD) by USGS (for Nepal event) as well as from ITalian ACcelerometric Archive (ITACA) – seismometers belong to Italian Strong Motion Network and Italian National Seismic Network. GPS-only data for the events came from: UNAVCO GPS Archive for Nepal earthquake, GPS stations belong there to California Institute of Technology in cooperation with National Seismological Centre. Sampling frequency of GPS data was 5 Hz. GPS data for Italian events came from high-rate GPS data archive database of the 2016 central Italy seismic sequence held by Istituto Nazionale di Geofisica e Vulcanologia (INGV) – GPS stations belong to RING Network (Rete Integrata Nazionale GPS), DPC Network (by Dipartimento di Protezione Civile), INGV CaGeoNet GNSS network and Regione Lazio GNSS network. Sampling frequency was 10 Hz.
In Nepal event there were analyzed data from 8 GPS stations, from which 2 were close to seismometer KATN (stations KKN4 and NAST in distance 11 km and 6 km, respectively). Two Italian earthquakes were recorded by collocated seismometers and GPS stations. For Visso earthquake there were analyzed 4 collocated pairs of sensors and for Norcia – 6 pairs, where the distance between sensors did not exceed 2 kilometers and the epicentral distance of collocated devices was below 100 kilometers (with one exception).
GPS data processing was done with RTKLib software in PPP kinematic mode using final CODE (Centre of Orbit Determination) orbits, Earth rotation parameters, differential code biases, and 5s satellite clocks. Processing window was 5-hour of observations, then were analyzed only 50-100 seconds time series of earthquake events, depending on time of waves arrival and the event length. Time series of displacements from seismic and GPS data were compared and revealed good agreement in terms of amplitude and polarization.
Paper presents the data processing scheme including the GPS data processing, de-trending of coordinate time-series and statistical evaluation of differences between seismic and GPS derived displacements.
Analyzed case study is a result of training in co-seismic GPS data processing to develop the methodology for Polish anthropogenic seismic events evaluation within the EPOS-PL project.