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Innovative Remote Sensing: Flood Monitoring using GNSS Reflectometry

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An increase of the intensity and frequency of extreme precipitation events are observed in the last decade due to climate changing conditions. Resulting floods pose significant socio-economic problems in areas like on the banks of the Mekong Delta with dense population. To quantify and predict the impact of these flooding events to the local population it is important to measure and understand the related hydrological processes. Satellite based altimetry offers water level measurements with high accuracy for oceans and very large rivers but typically with insufficient spatio-temporal resolution. The accuracy decreases in coastal areas. Water level gauging instruments offer a high accuracy and temporal resolution but for a single location only. However, the number of water level gauging stations worldwide is decreasing. GNSS-Reflectometry (GNSS-R) can fill the gap between these two measurement methods. Earth reflected L-band signals from the Global Navigation Satellite Systems (GNSS) show a high reflectivity on water surfaces. This property is used to derive water level height changes. In principle two different GNSS-R altimetry methods exist: based on code or carrier phase observations. Our research activities focus on the phase-based altimetric application of GNSS-R. In March 2012, a two-week measurement campaign was conducted in Can Tho City, Vietnam within the WISDOM (Water related Information System for the sustainable Development Of the Mekong Delta) research project. Several reflection traces on the 150 m wide Can Tho River section are recorded with a dedicated GNSS-R receiver developed in cooperation between GFZ and JAVAD. To track the direct and the reflected signal separately, two antennas are used. The analysis of the recorded signals shows a superposition of the signal reflected by the water surface with other multipath signals. These occur due to the surrounding of the antennas (vegetation, buildings). To separate these different multipath signals and to filter out the one reflected by the water surface an adapted Hilbert Huang Transform (HHT) and a model of the observations are applied. The HHT offers the advantage that no a priori base is needed like the trigonometric functions in case of Fourier Transform or a mother wavelet in case of Wavelet Transform. No stationarity or linearity of the signal has to be assumed, as it is a fully data-driven signal analysis method. In a second step, a Least-Squares Method is used to determine the water level height. First results show a correlation of 0.84 (RMS 5 cm) with water level changes registered from a water level gauging instrument placed 8 km away from the measurement place.