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The emergence of low-cost GNSS-IR sensors for surface change monitoring: a case study of the RPR network for measuring the Rhine River level

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GNSS Interferometric Reflectometry (GNSS-IR) is redefining its role as an innovative technique in environmental sensing. However, geodetic-quality GNSS receivers and antennas are still very expensive instruments which limits their use as dedicated environmental sensors. Recently, low-cost GNSS-IR sensors have been developed for monitoring surface changes such as water level, snow depth and soil moisture. Real-time signal-to-noise ratio (SNR) observation, the key observable of ground-based GNSS-IR, can open up a range of possibilities for environmental monitoring with low cost sensors that can operate unattended for long periods of time. We have recently successfully developed a low-cost water-level sensor called Raspberry Pi Reflector (RPR) based on GNSS-IR technique (Karegar et al. 2022, *Water Resources Research*, 58). In spring and summer 2023, a network of eight RPRs was installed along the Rhine, the largest river in Germany, from Petersau to Sankt Goar. We installed some of these RPRs in a relatively steep and narrow middle Rhine valley, where the terrain relief around the instrument can influence the effectiveness of the GNSS-IR approach. The water level measurements provided by these sensors are used to validate the SWOT observations of surface water levels. In this presentation, we will present the results of the deployment of the RPRs and discuss the challenges associated with these low-cost sensors.