Towards tide gauges selection for model-based hydrodynamic leveling connections; with application to assess the potential impact on the quality of the European Vertical Reference Frame

Yosra Afrasteh¹, Cornelis Slobbe¹, Martin Verlaan², Martina Sacher³, Roland Klees¹, Henrique Guarneri¹, Lennart Keyzer¹, Julie Pietrzak¹, Mirjam Snellen¹, and Firmijn Zijl²

¹Technical University of Delft, Delft, Netherlands, (y.afrasteh@tudelft.nl)
²Deltares, Delft, Netherlands
³Federal Agency for Cartography and Geodesy, Frankfurt, Germany

Model-based hydrodynamic leveling allows transferring heights between tide gauges by means of model-derived mean water level (MWL) differences between them. In this study, we aim to exploit the technique to improve the quality of the European Vertical Reference Frame (EVRF). In doing so, the candidate tide gauges must fulfill two criteria. First, they must be connected to the Unified European Leveling Network (UELN). Second, the hydrodynamic model to be used should be capable of resolving the local MWL at the tide gauge locations. The latter can be very challenging as some tide gauges are located in areas with complicated hydrodynamic processes. To identify which tide gauges have the largest impact on the quality of the EVRF, we conducted geodetic network analyzes. Here we used all tide gauges within 10 km of UELN height markers. Moreover, we assumed to have access to a hydrodynamic model covering all European seas, or alternatively regional models for separate basins, providing the MWLs with uniform precision. Our results indicate a reduction of the mean propagated standard deviation of the adjusted heights between 20% to 40% compared to the UELN-only solution. The magnitude of the improvement depends on the setup of the experiment and the selected noise level for model-derived MWL differences. Detailed analysis shows that we already obtain a significant improvement (>20%) by adding only a limited number of hydrodynamic leveling connections. Moreover, we found that the tide gauges located in the countries with the most UELN height markers are most profitable in terms of improvement. The impact hardly depends on the tide gauges' geographic location, which shows the method's freedom and flexibility in selecting the tide gauges.