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Exploring low-cost alternatives to obtain higher density precipitation data collection in urban areas

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In urban catchments prone to pluvial flooding, due to the short response times of these catchments, rainfall data with high spatial and temporal resolution are required to increase reliability of pluvial flood modelling. Whether an intense and localized rainfall event triggers a pluvial flood, highly depends on the precise location and rainfall values of the high intensity locations at the local scale.

One of the objectives of the FloodCitiSense project, which aims to develop an early warning service for pluvial flooding in urban areas, is to explore the potential of alternative data sources for near real-time rainfall observation at ground level in urban areas via low-cost sensors and citizen science. The pilot cities within FloodCitiSense are Brussels, Rotterdam and Birmingham. In this abstract we focus on Brussels as case study.

A professional network of 16 rain gauges (Flowbru.be) covers the Brussels Capital Region (162 km^2) and provides open data in real-time. Although the spatial distribution of this network is rather dense, there are parts of the city with missing rainfall data. The specific topography of the Brussels Region moreover has an influence on the spatial distribution of rainfall over the region. Therefore we explore potential alternative (low-cost) sources to complement the professional rain gauge observations.

A first alternative source is a network of relatively cheap commercial rain gauges (NetAtmo), which provide data in near real-time. We analysed the availability, quality and usefulness of the NetAtmo data by comparing with the professional network data. We collected one-year hourly rainfall measurements from several NetAtmo stations in Brussels and compare the rainfall data with the Flowbru professional rain gauge stations within two kilometres radius. The NetAtmo stations have on average 30 to 35% missing data and after removing the missing data they record slightly less amount of rainfall volume compared to the professional rain gauges. The Pearson correlation coefficients between the rainfall observations of the two rain gauge types on average are over 0.7.

A second source is to deploy a network of low-cost sensors with the help of citizens (citizen science concept). The low-cost sensor measures the raindrop arrival rate by measuring by simple counting the number of drops hitting a piezo element. The piezo is placed on a 3D printed holder and the signal is processed by an Arduino datalogger. 20 low-cost sensors were installed, enabling to fill the gaps in the professional rain gauge network. Preliminary results are erratic, mainly due to difficult operation conditions (heat wave, water infiltration) as well as hard/software issues.

Thirdly, we evaluate the intense rainfall quantification and pluvial flood occurrence via the FloodCitiSense App, which has been co-created with citizens and water actors. The data collection is done by enabling citizens to report via the MobileApp on rainfall intensity (5 categories) and pluvial flood occurrence (8 categories). This reporting is currently being tested.

A preliminary conclusion is that the low-cost alternatives surely has potential to complement professional rainfall data collection, but that their remain still quite some challenges before turning them into operational products.