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Measuring Run-Off Dynamics from Pavements using the Weighable Tipping Bucket

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Due to climate change, cities need to adapt to changing rainfall and rainwater run-off dynamics.
In order to get an appropriate data base for an corresponding process based water balance model for pavements, we
had to improve the measuring method for urban run-off dynamics. We tinkered an old tipping bucket to a digital balance, called that a weighable tipping bucket (WTB) and were able to measure run-off from our paved lysimeters with an substantially increased temporal and volume resolution.
Traditional tipping buckets (TB) have a volume resolution, capable to quantify the highest intensities in a range of expected flows. This results in varying temporal resolutions for varying flow intensities, especially in low resolutions
for small flow events. Therefore, their applicability for run-off measurements and other hydrological process studies is limited, especially when dynamics of both small and storm events shall be described.
This paper introduces the device set up and an according data processing concept. The improved volume and temporal resolution of the WTB are demonstrated. The impact of that increased resolution on our understanding of run-off dynamics from paved urban soils are discussed, exemplary for the run-off and the surface storage of a paved urban soil.
The study was conducted on a permeably paved lysimeter situated in Berlin, Germany. Referring to the paved surface, the TB has a resolution of 0.1 mm, while the WTB has a resolution of 0.0005 mm. The temporal resolution of the WTB is 3 s, the TB detects individual tippings with 0.4 s between them. Therefore, the data processing concept combines both the benefits of the balance and the TB.
During a five months period (July to November 2009) 154 rain events were detected. Accordingly, the TB and WTB detected 47 and 121 run-off events. The total run-off was 79.6mm measured by the WTB which was 11% higher than detected by the TB. 95% of that difference can be appointed to water, which evaporated from the TB. To derive a surface storage estimation, we analyzed the WTB and TB data for rain events without run-off. According to WTB data, the surface storage of the permeable pavement is 1.7 mm, while using TB data leads to an overestimation of 47% due to low volume resolution of the TB.
Combining traditional TB with modern, fast, high resolution digital balances offers the opportunity to upgrade existing TB systems in order to improve their volume detection limit and their temporal resolution, which is of great advantage for the synchronization of water balance component measurements and the investigation of hydrological processes.

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