EGU2014-7180

Analysis of splash loss for different throughfall trough designs

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Abstract

Measurement uncertainty through splash losses is a known issue in rainfall measurements. In the case of rain gauges this has resulted in standard funnel designs. In forest hydrology and specifically for throughfall measurements few standard trough designs or evaluation reports exist. We present a laboratory experiment in which the splash loss for different trough types were systematically compared and give a recommendation which trough designs show the least splash losses.

For throughfall troughs the cross-sectional shape of the pipe or trough determines the magnitude of splash loss. To assess which trough design is most suitable four alternatives were built and tested in the laboratory: a classic half pipe, a u-shaped pipe with a (7 cm high) border, an elongated u-shaped pipe (10 cm high), and an open pipe with a sectorial opening.

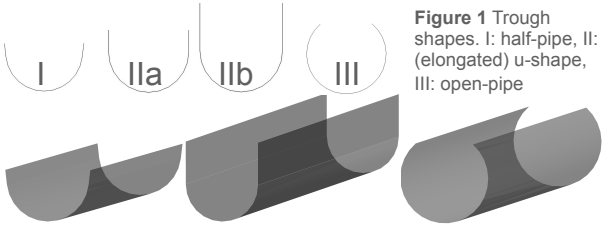

Figure 1 Trough shapes. I: half-pipe, II: (elongated) u-shape, III: open-pipe

The splash loss was determined by dripping dyed water into the different designs and collecting the splash on paper sheets mounted next to the pipes. The paper sheets were then scanned and processed so that the area of the sheets covered by splash could be quantified.

Experiment design & data analysis

For the comparison of the different trough types a laboratory setup (Fig. 2) with (1) a constant drip, (2) a projection area, and (3) a 50cm trough section was used. For each trough type 10 repetitions (100 drips of coloured water per run) were done (detailed specifications, Tab. 1).

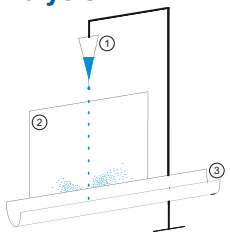

Figure 2 Experimental setup. (1) water reservoir, (2) projection area, (3) trough section.

Shape	I half pipe	II a u-shape	II b u-shape	III sectorial opening
Drop size	4 [mm] diamteter			
# of drips	100			
Drip height	50 [cm]			
Drip location	Trough center			
Collection area	A4 sheet			
# of samples	10 repetitions per trough type			
Trough slope	12°			
Opening [cm]	7.5	6.5	6.5	6.5
Height [cm]	5	7	10	10
Diameter [cm]	7.5	6.5	6.5	10

Table 1 Experiment details

Figure 3 Experimental setup with paper sheet and scanned, preprocessed images converted to binary

After scanning the A4 sheets the images were pre-processed to ascertain a uniform image size. To extract the splash area a binary conversion to black & white was done (Fig 3). The percentage of black pixels was taken as a metric to quantify and compare splash loss of different trough designs.

Results

The four trough types show different splash loss behaviour. As a metric the % total area (A4 sheet) covered by splash was taken. Fig. 4 clearly shows that a half-pipe shape comes with the highest losses. U-shaped and sectorial opening types come with substantial improvements. The construction of the different trough sections for the experiment design further showed that the sectorial opening, next to the half-pipe, is the easiest build.

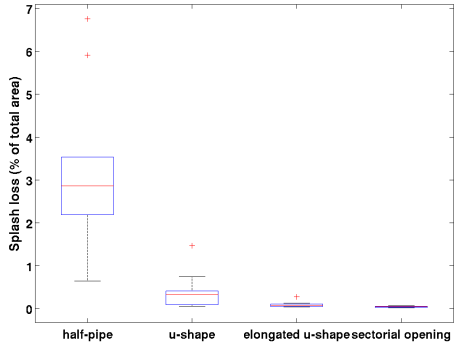

Figure 4 Splash loss (in %) for the different trough designs

Conclusions

- Minimum splash loss for elongated u-shape and sectorial opening shapes
- Technically the sectorial opening is easier to manufacture
- Results show differences between the cross-sectional designs. For a quantification of splash loss in relation to precipitation amount different experiment setups have to be considered

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Acknowledgements

This project was done in the framework of the German Terrestrial Environmental Observatories (TERENO) initiative and is part of the intensive research site 'Hohes Holz' within the TERENO Harz/Central German Lowland Observatory.