Test description

1. Experimental setup

Experiments consist of measuring surface flow velocities in an urban drainage physical model analysing the displacement of tracers between two consecutive frames. Frames were obtained from 4k and 25 fps videos recorded by two Lumix GH4 cameras (focal length equal to 28 mm), which were installed 2.2 m above the sidewalk of the physical model, covering the first two meters of roadway from the curb. Figure 1 shows a scheme of the experimental setup. For each of the three rain intensities (30, 50 and 80 mm/h) that the simulator can generate, this dataset provides videos i) using fluorescent particles as tracers and ii) recording reflects and small bubbles generated by raindrop impacts in runoff without tracers. Fluorescent particles have a mean size of 0.85 mm and a density of 1.19 g/cm^3, and are obtained by cutting extruded 3D-printer fluorescent filament. The setup is completed with UV torches located next to the cameras and pointing the measuring area to highlight fluorescent particles. Reference points disposed in a 0.5 m x 0.5 m grid were drawn on the surface allowing orthorectify the frames recorded. Further details of physical model can be consulted in Naves et al. (2019a, 2019b).

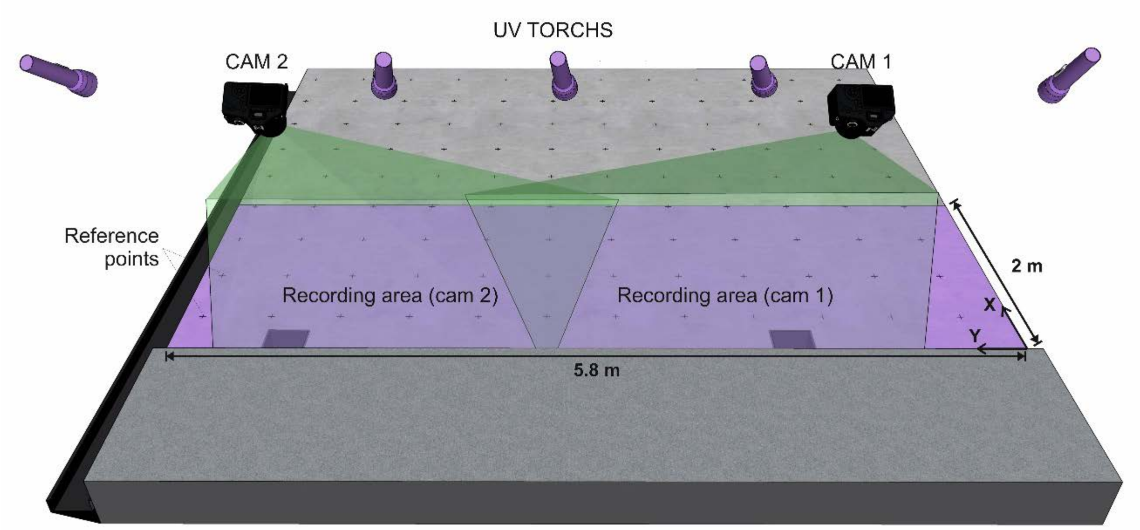

Figure 1. Experimental setup scheme.

2. Experimental procedure

Fluorescent particles tests start spreading particles over the model surface. Cameras start recording and ambient lights are turned off. Then, UV torches are turned on and a steady and uniform rainfall is generated. As the particles are washed-off by surface flow, it is necessary to add more particles in the roadway side during video recording. Steady runoff conditions are reached after approximately 150 s. For videos without particles, the same methodology is followed but replacing the UV torches by LED flood lights. Experiments ID and configurations are showed in Table 1. Raw videos for each experiment are included in '*2_ID_RawVideos_*.zip*'. The first part of the experiment with 80 mm/h of rain intensity and fluorescent particles was not recorded. Instead, an initial recording to extract a calibration frame and a steady flow conditions video is provided. In addition, large video files were split to reduce maximum size of files.

Table 1. Configuration of performed experiments.

Test ID	Rain intensity (mm/h)	Particles?	Illumination
1	30	Yes	UV
2	50	Yes	UV
3	80	Yes	UV
4	30	No	flood light
5	50	No	flood light
6	80	No	flood light

3. Data postprocessing

Dataset also provides postprocessed frames and velocity results in steady conditions. To do this, 1500 frames (60 s) are extracted for each video and analysed to obtain a mean velocity distribution. Table 2 includes the times in each video of the first and last frame considered for the PIV analysis.

Table 2. Frames extracted from raw videos for analysing steady velocity distributions.

Test ID	**Video**	**Time first frame (s)**	**Time last frame (s)**
1	Particles_30mmh_Cam1 (2)	0	60
1	Particles_30mmh_Cam2 (2)	0	60
2	Particles_50mmh_Cam1 (2)	70	130
2	Particles_50mmh_Cam2 (2)	70	130
3	Particles_80mmh_Cam1_steady	150	210
3	Particles_80mmh_Cam2_steady	142	202
4	NoParticles_30mmh_Cam1 (2)	0	60
4	NoParticles_30mmh_Cam2 (2)	0	60
5	NoParticles_50mmh_Cam1	198	258
5	NoParticles_50mmh_Cam2	198	258
6	NoParticles_80mmh_Cam1	208	268
6	NoParticles_80mmh_Cam2	218	278

Postprocessing of frames starts performing a spatial calibration to rectify the angle of the cameras and the lens distortion, and join the images from each camera. Matlab algorithm ‘fitgeotrans’ was applied identifying in each video the reference points drawn in the model surface in order to transform video frames to an orthogonal reference system. ‘*3_SpatialCalibration.zip*’ includes spatial coordinates of the reference points showed in Figure 2 (‘*Reference_points.csv*’) and provides calibration frames extracted from both cameras for each test.

Then, frames are converted to greyscale and a sliding background filter was applied transforming to black those pixels with 25% of similarity in the grey value with the same pixel from the previous frame. The PIV tool for Matlab PIVLab (Thielicke and Stamhuis, 2014) is used to obtain velocities (using interrogation areas of 128, 64 and 32 pixels as settings) and a temporal 2D filter (Goring and Nikora, 2002) is applied to delete outliers. Finally, after a spatial median filter of 3x3 elements using the Matlab toolbox 'pivmat' (Moisy, 2017), the surface velocity distribution is obtained from the mean of all the frames. For frames without particles, the same methodology is followed but with a sliding background threshold of 10%. The sets of frames used as input for PIVLab in each experiment are provided in '*4_ProcessedFramesd_SteadyFlow.zip*'. In the rectified frames, 1 pixel correspond to 1 mm. More details of the followed methodology to obtain velocity distributions can be consulted in Naves et al. (2019c).

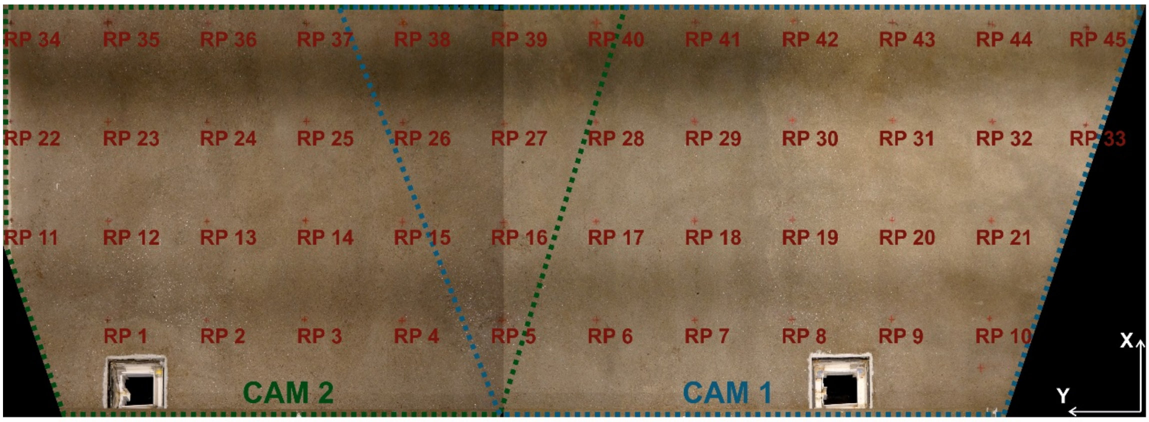

Figure 2. Rectified and joined calibration images showing reference points drawn in model surface and recording area of each camera.

4. Results

'*5_VelocityResults.zip*' includes mean steady x- and y-velocity distributions for each experiment resulted from the PIV analysis with a spatial resolution of 32 mm. Velocity results are provided in csv files in 64x181 matrices and the position of each row and column are in '5.0_X(m).csv' and '5.0_Y(m).csv' respectively. Figure 3 shows results obtained for experiment 1.

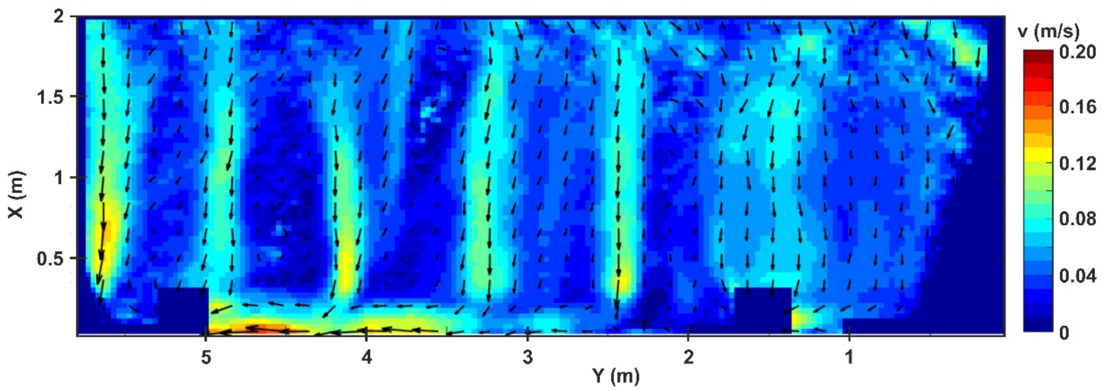

Figure 3. Mean velocity distribution in steady conditions resulted from test 1.

References

Goring, D.G., Nikora, V.I. (2002). Despiking acoustic Doppler velocimeter data. J Hydraul Eng. 128 (1), 117–126. http://www.doi.org/10.1061/(ASCE)0733-9429(2002)128:1(117)

Moisy, F., 2017. PIVMat. Available at: http://www.fast.u-psud.fr/pivmat/ [Accessed: 25 Jun 2019].

Naves, J., Anta, J., Suárez, J., Puertas, J. (2019a). WASHTREET Hydraulic, wash-off and sediment transport experimental data in an urban drainage physical model [Data set]. Zenodo. http://doi.org/10.5281/zenodo.3233918

Naves, J., Puertas, J., Suárez, J., Anta, J. (2019b) WASHTREET - Application of Structure from Motion (SfM) photogrammetric technique to determine surface elevations in an urban drainage physical model. [Dataset]. Zenodo. http://doi.org/10.5281/zenodo.3241337

Naves, J., Anta, J., Puertas, J., Regueiro-Picallo, M., Suárez, J. (2019c). Using a 2D shallow water model to assess Large-Scale Particle Image Velocimetry (LSPIV) and Structure from Motion (SfM) techniques in a street-scale urban drainage physical model. Journal of Hydrology, 575, 54-65. https://doi.org/10.1016/j.jhydrol.2019.05.003

Thielicke, W., Stamhuis, E.J. (2014). PIVlab – Towards User-friendly, Affordable and Accurate Digital Particle Image Velocimetry in MATLAB. J. Open Res. Softw. 2 (1), e30. DOI:10.5334/jors.bl.