Supplement of Nat. Hazards Earth Syst. Sci., 16, 1413–1429, 2016
http://www.nat-hazards-earth-syst-sci.net/16/1413/2016/
doi:10.5194/nhess-16-1413-2016-supplement


Natural Hazards and Earth System Sciences
Open Access

*Supplement of*

# Hydrodynamics of long-duration urban floods: experiments and numerical modelling

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# Supplement 1

Assuming a scale factor 1 / 200 for horizontal dimensions, the widths of the narrow and wide streets in the laboratory model correspond respectively to 10 m and 25 m at the prototype scale, which is considered as realistic.

Using the same scale factor for vertical dimensions would have led to very small water depths in the laboratory model (e.g., a water depth of 2 m in a real-world floodplain would have been represented by a 1 cm water depth in the laboratory model). Such small water depths would have resulted in significant measurement errors and particularly low Reynolds numbers in the laboratory model. Therefore, a distorted model was considered, assuming a vertical scale factor of 1 / 20.

According to the Froude similarity, the scale factor for velocity was defined as the square root of the scale factor for vertical dimensions: $( 1 / 20 )^{0.5} \approx 0.22$. Hence, the scale factor for discharge is: $( 1 / 200 ) \times ( 1 / 20 ) \times ( 1 / 20 )^{0.5} = 5.6 \times 10^{-5}$.

Next, the values of inflow discharge to be supplied to the laboratory model were deduced from typical real-world observations (Mignot et al., 2006) considering moderate and extreme flood conditions, as detailed in Table S1 below. In the end, the range of investigated inflow discharges was slightly extended to 10 ÷100 m³/h.

*Table S1: Scaling of the experimental model according to the Froude similarity for moderate and extreme flood conditions as reported by Mignot et al. (2006).*

| | Moderate flood conditions | Extreme flood conditions |
|---|---|---|
| Typical real-world water depth | 0.3 m | |
| Typical real-world flow velocity | 1 m/s | |
| Discharge in real-world narrow streets (10 m in width) | 3 m³/s | 20 m³/s |
| Discharge in real-world wide streets (25 m in width) | 7.5 m³/s | 50 m³/s |
| Inflow discharge in the narrow streets of the laboratory model | 0.6 m³/h | 4 m³/h |
| Inflow discharge in the wide streets of the laboratory model | 1.5 m³/h | 10 m³/h |
| Total inflow into the laboratory model | 11.2 m³/h | 74.5 m³/h |

# Supplement 2

| Test ID | Observed | Computed |
|---|---|---|
| Q020-W050 | | |
| Q060-W050 | | |
| Q080-W050 | | |
| Q100-W050 | | |

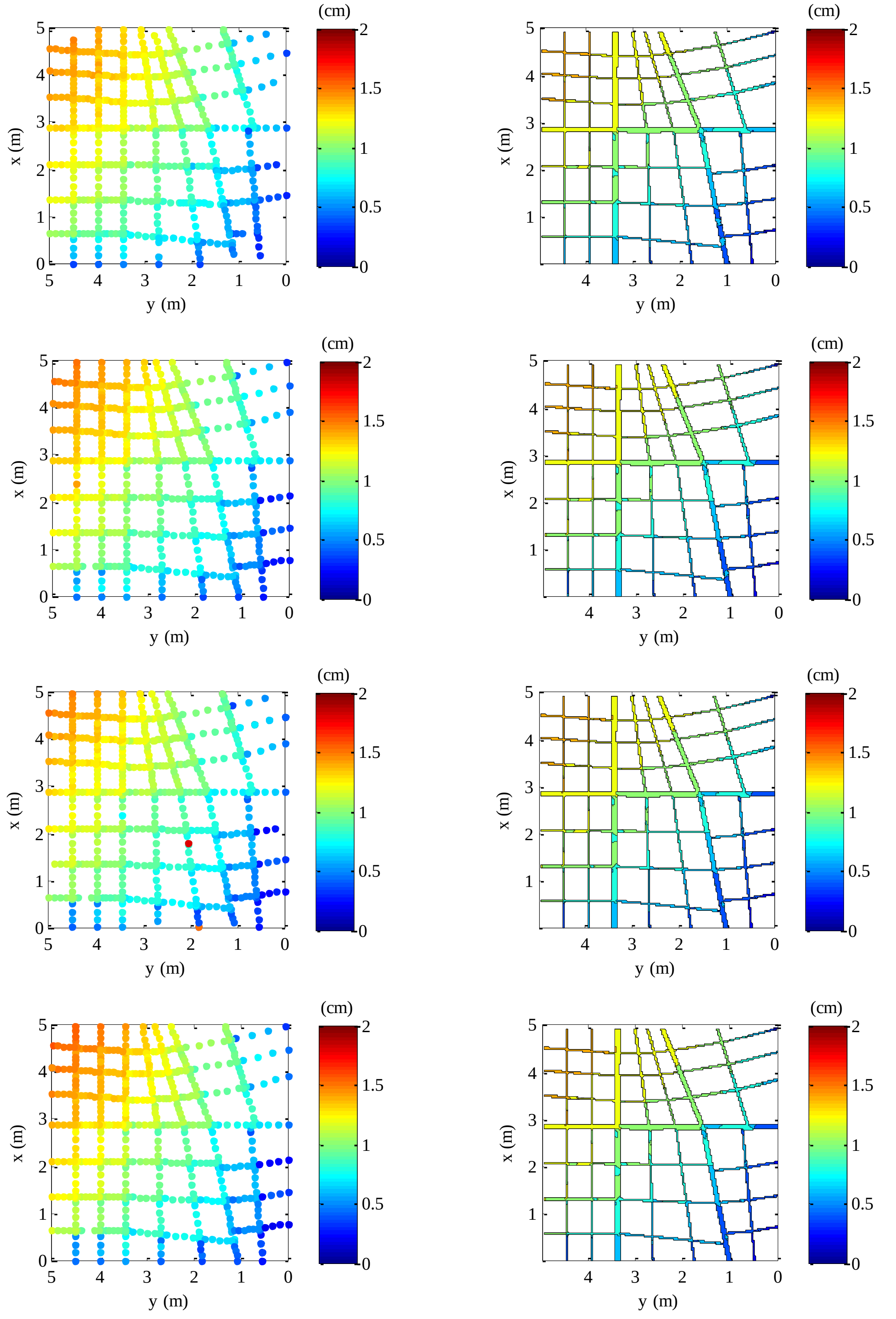


*Figure S1: Observed and computed water depth distributions scaled by the district-averaged water depth, for inflow discharges from 20 m³/h up to 100 m³/h.*

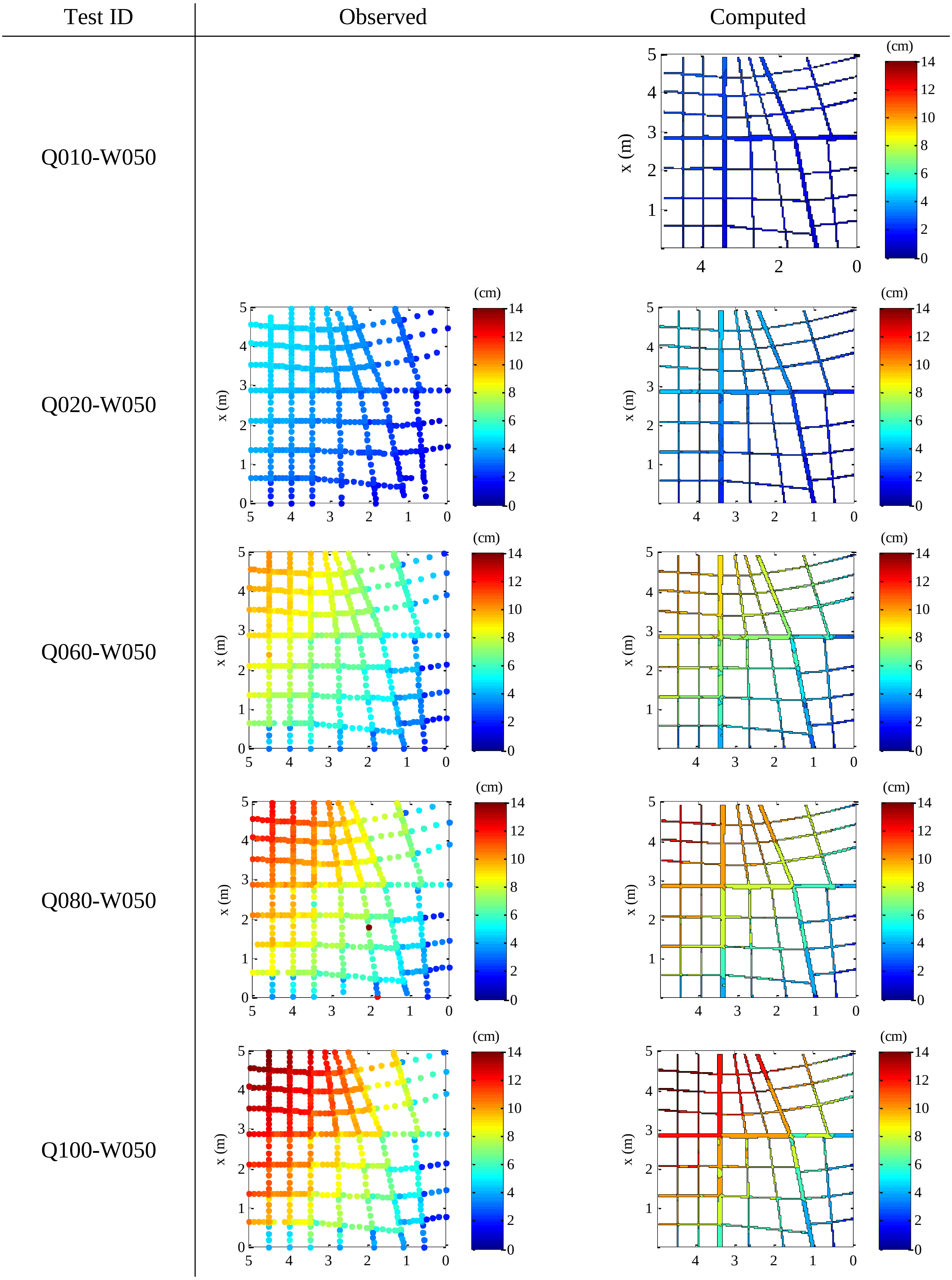


*Figure S2: Observed and computed water depth distributions for inflow discharges from 10 $m^3/h$ up to 100 $m^3/h$.*

# Supplement 3

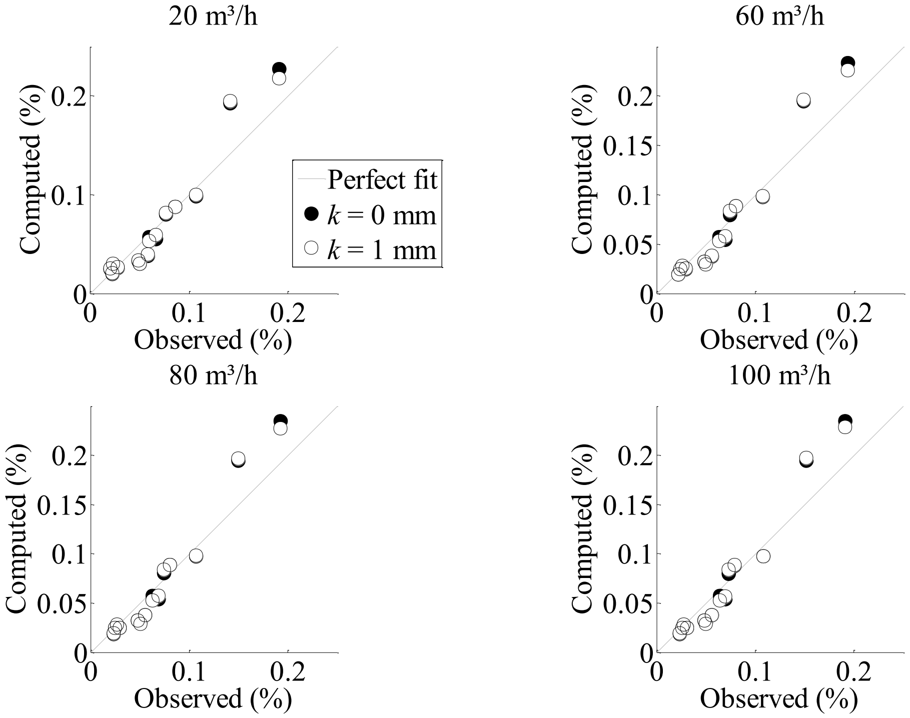


*Figure S3: Computed vs. observed distribution of outflow discharges in each street (in percent of the total inflow), considering two different roughness heights k in the computation.*

*Table S2: Root mean square error on the outflow discharges in each street (expressed in percentage of the total inflow), as a function of the total inflow and for different friction modelling.*

| Friction formula | Friction coefficient | 10 m³/h | 20 m³/h | 60 m³/h | 80 m³/h | 100 m³/h |
|---|---|---|---|---|---|---|
| Colebrook | $k$ = 0 mm | 2.0 % | 1.8 % | 1.9 % | 1.9 % | 2.0 % |
| Colebrook* | $k$ = 0 mm | 1.9 % | 1.7 % | 1.8 % | 1.9 % | 2.0 % |
| Colebrook | $k$ = 1 mm | 1.9 % | 1.7 % | 1.8 % | 1.9 % | 1.9 % |

* simulation conducted with the $k$-$\varepsilon$ turbulence model.

# Supplement 4

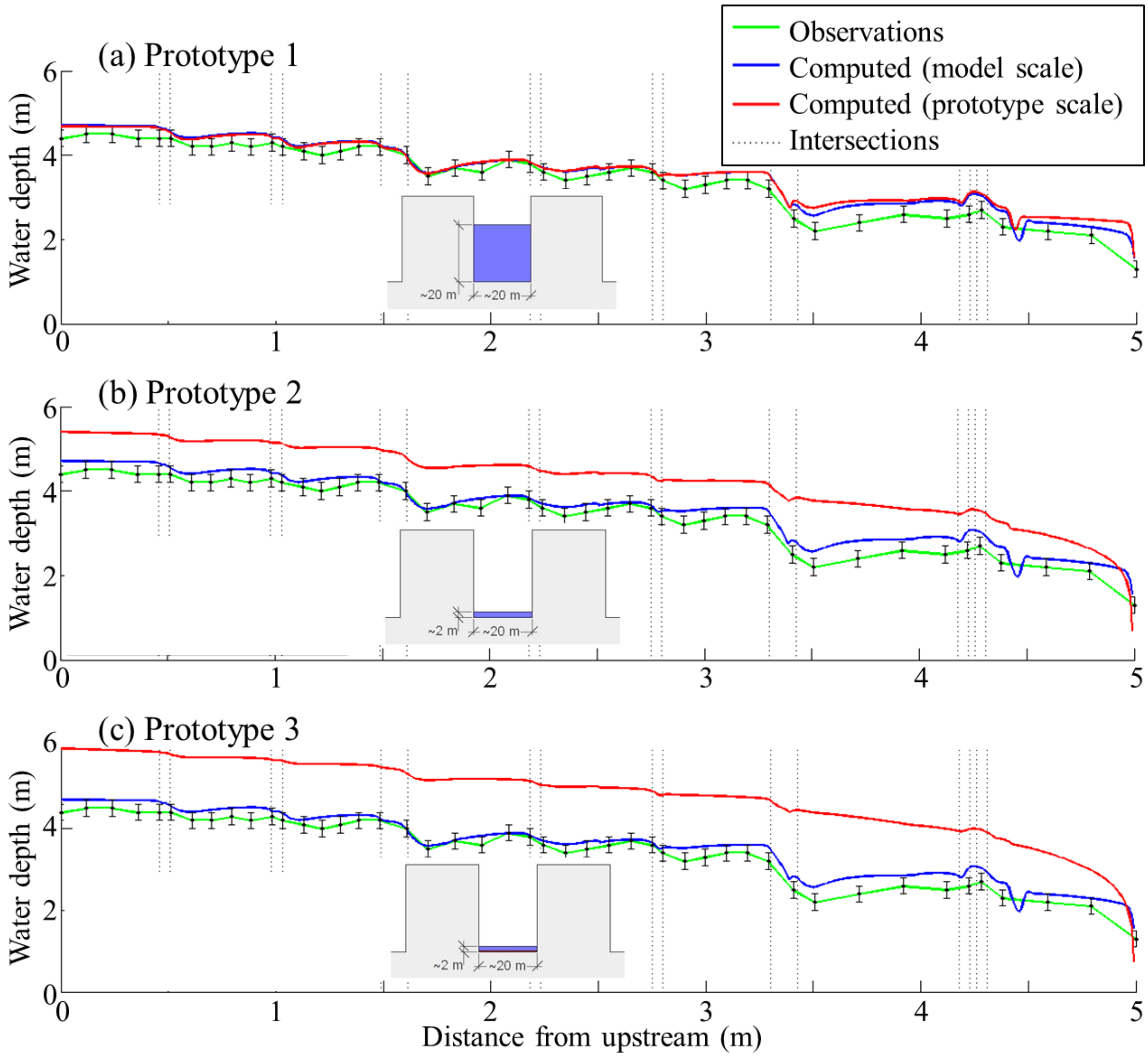


*Figure S4: Observed water depths in street 4 vs. computations performed at the scale of the experimental model and at the prototype scale (see Table 5 for a definition of Prototype 1, 2 and 3).*