Hydrodynamic analysis of a stormwater system for decision-making process: The Duran case study (Ecuador)

Matamoros D.E., Arias-Hidalgo M. and Borbor-Cordova M.J.

Study Site

- Duran town located at river Babahoyo – Guayas (20 – 100 hab/ha)
- March 25 – 28 (2015): 103 mm (6 h and 21 mm – average per rain)
- Meteorological stations:
  - *Divino Niño* (Durán): daily records 2013 – 2017 (Max rain in April 3-4, 2015: 106.4 mm)
  - *Airport* (Guayaquil): annual records 1962 – 2017

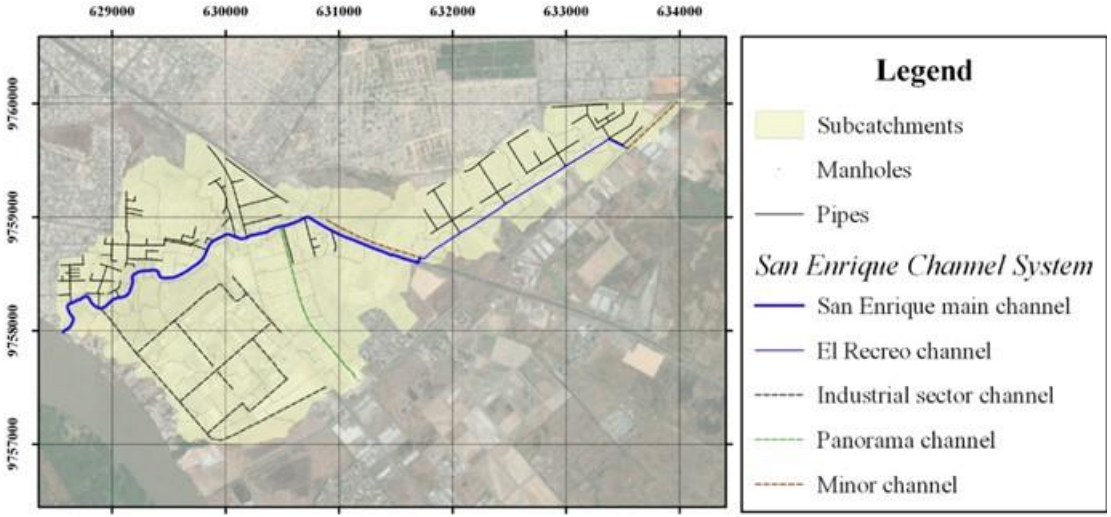
Parameter	Value	Record period
Average annual precipitation (mm)	1115.0	1961 – 2017
Average maximum 24-h precipitation (mm)	25.1	1962 – 2012
Average annual rainy days	103	1962 – 2012
Maximum 24-h precipitation for 2-yr return period (mm)	94.1	1962 – 2012
Maximum 24-h precipitation for 5-yr return period (mm)	126.5	1962 – 2012
Maximum 24-h precipitation for 50-yr return period (mm)	195.5	1962 – 2012

"normal" rain, tide influence and poor design → Floods

Water depths: 10 – 40 cm

Stormwater System

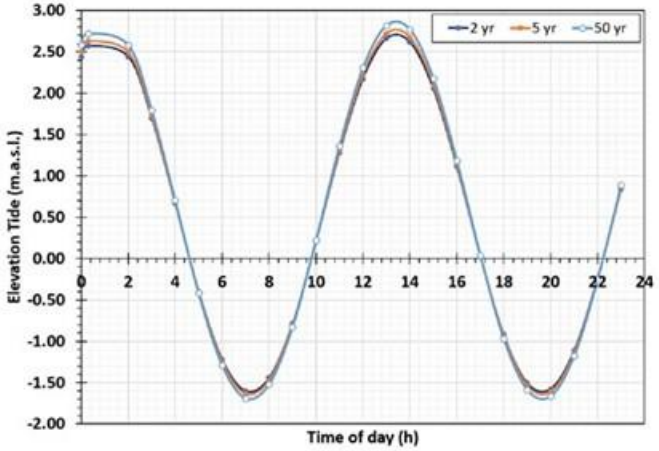
- Several channel systems discharging into river but only one with enough information
- *San Enrique* system (7.1 km²)
  - 15.5 km of ground channels
  - 16 pipe collectors (18 km)
  - 9% of total area does not have information



Flood Modelling

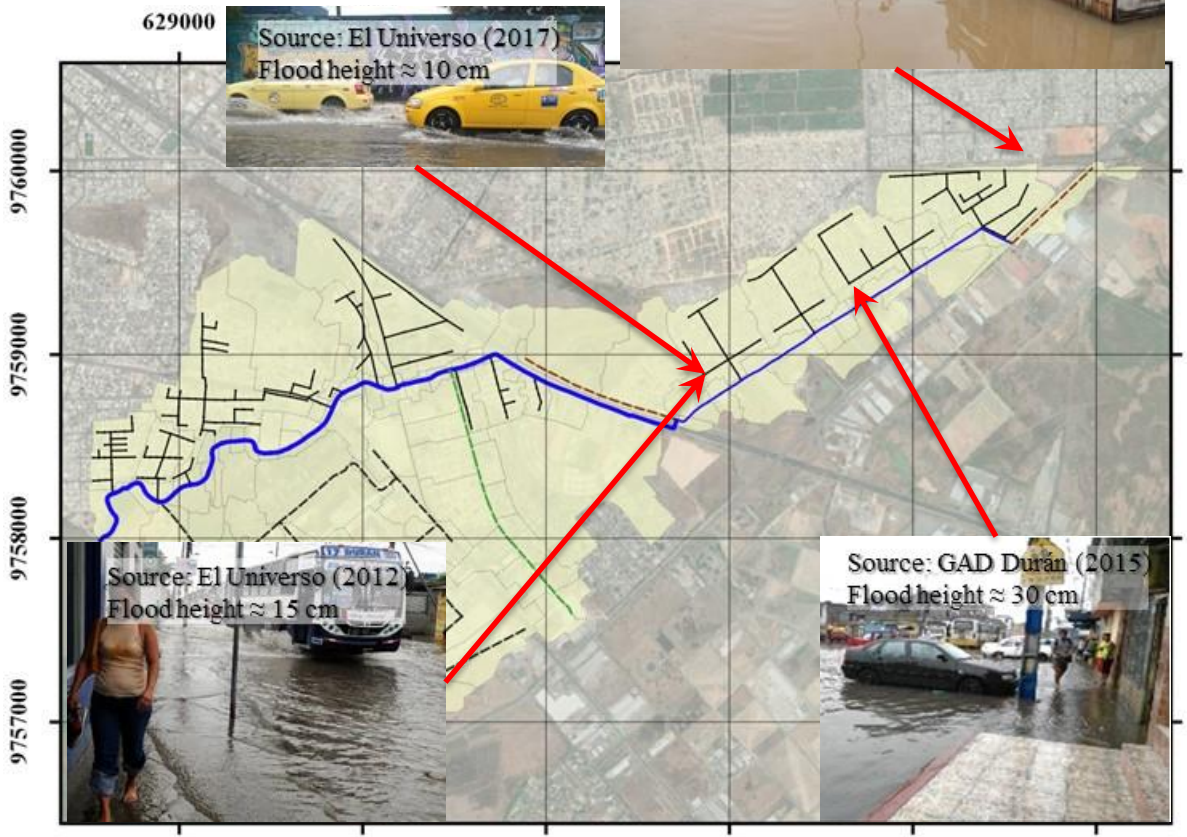
Source: El Universo (2015)

- EPA SWMM (Rossman & Huber 2015, 2016; Rossman 2017)
- Scenario analysis:
  - "normal" tide (2-yr event) + no rain
  - "normal" tide + "normal" rain (frequent rain)
  - "normal" tide + "design" rain (5-year event)
- Tide data from Guayaquil city
- Main **uncertainties** in model:
  - Manning's roughness in ground channels (Arcement & Schneider 1984),
  - waste clogging in pipe system (not considered in present study)
- Main **drawback**: calibration process due to lack of flood data (heights and flow)



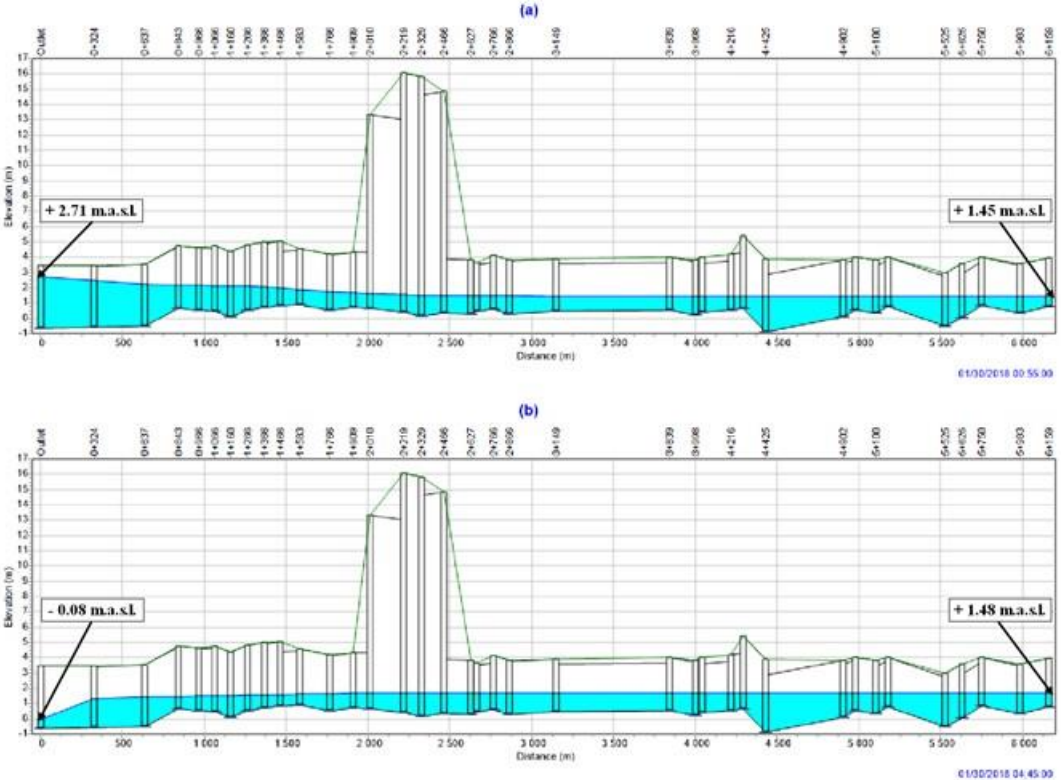
Alternate Calibration

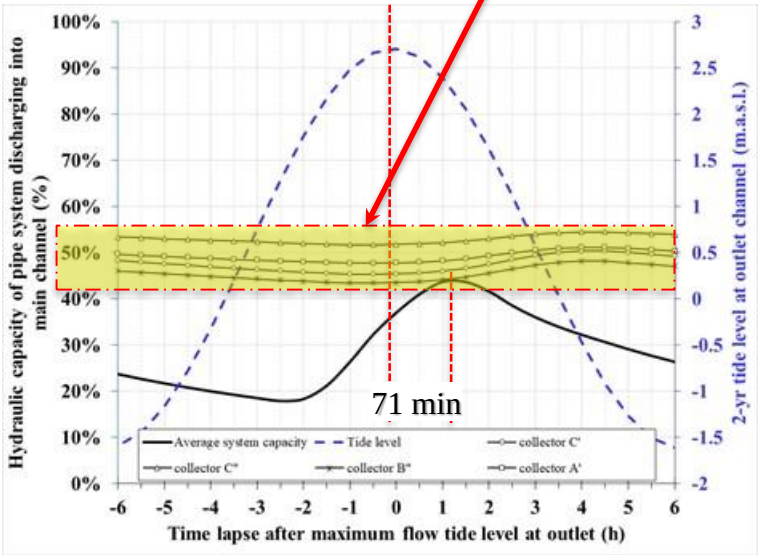
- Use of on-site photos for urban flooding areas (Wang *et al*. 2018)
- Sources: newspapers and tv media (2012 – 2017)
- Flood heights are quite similar during “normal” rainfalls (2-yr events)



1st Scenario: 2-yr tide + no rain

Pipe collectors connected to *San Enrique – El Recreo* main ground channel (blue line) discharging below water level.





4 pipe collectors are half-flooded 24/7

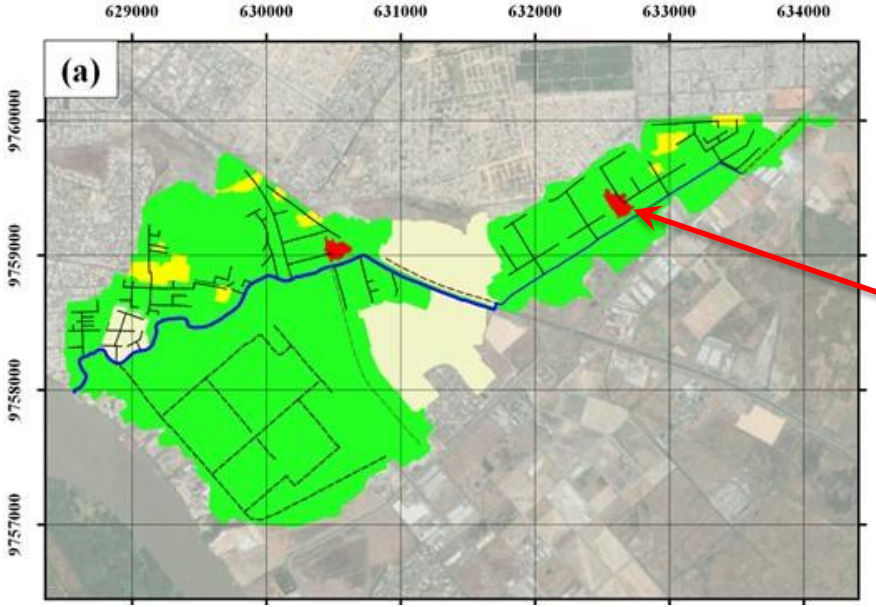
2nd Scenario: 2-yr tide + 2-yr rain (94 mm)

- 2-yr rain: 50% chance of occurrence every year
- Flood hazard zoning proposed after Pregnolato *et al.* (2017)

Hazard Category	Range of flooding depth (m)	Range of flooding flow (l/s)	Range of flooding duration (min)
Null/low	< 0.05	< 60	< 90
Medium	0.05 – 0.15	60 – 190	90 – 280
High	> 0.15	> 190	> 280

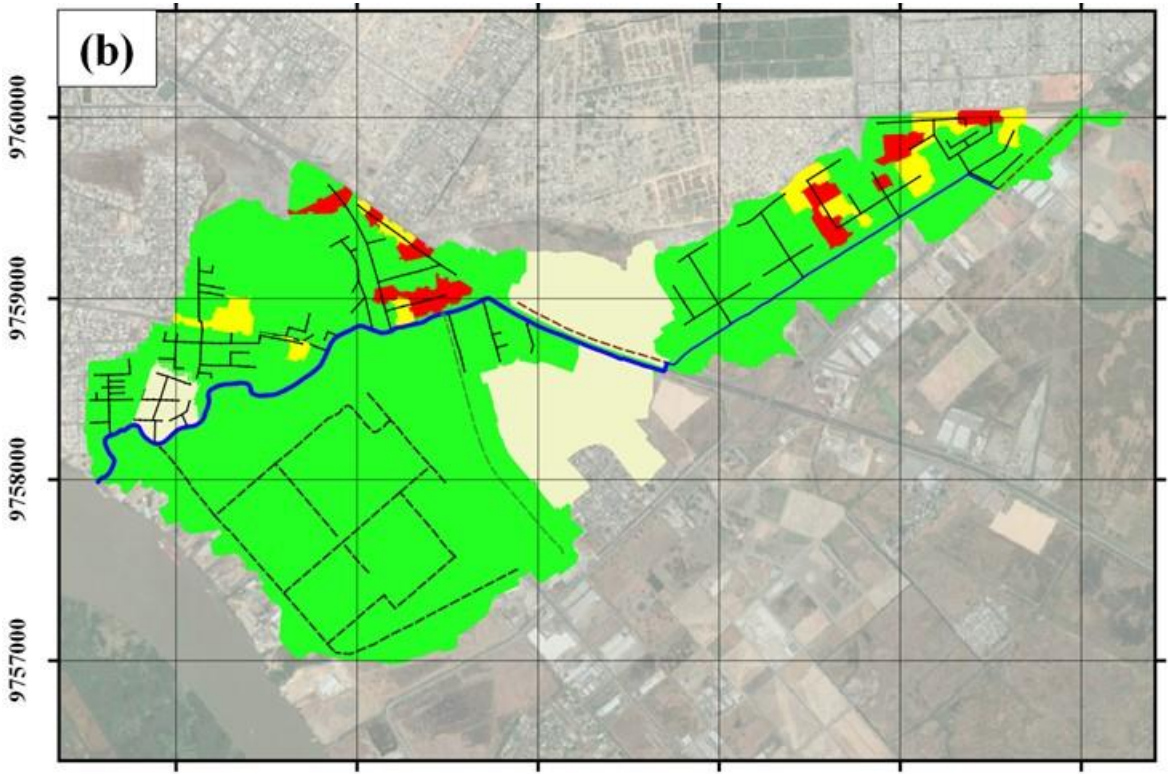
Remember:

Clogging due to waste on streets, sinks and pipes was not considered in model



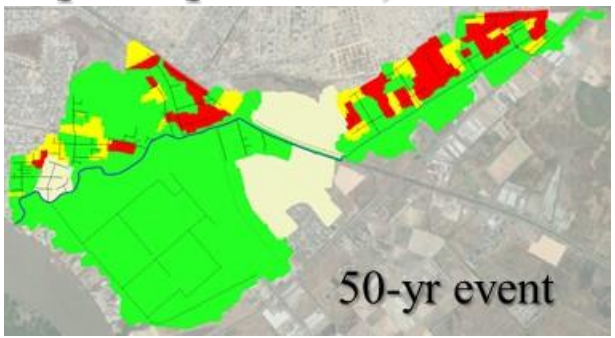
3rd Scenario: 2-yr tide + 5-yr rain (126 mm)

- Local regulation enforces to design pipe systems for a 5-yr event with null/low hazard flooding.



Conclusions

- Model represents fairly well frequent flooded areas in *San Enrique* catchment.
- Pipe system is not functioning with its full capacity (floods are likely to occur with any rainfall)
- Waste accumulation is increasing flood problem (heights and duration)
- Climate change (sea level rise or higher precipitation) could worsen flooding



Future tasks

- Municipal government of Duran must
  - Conduct future monitoring of floods
  - Update information regarding whole pipe and channel system
  - Improve street and channel cleaning
  - Enforce “green” infrastructure (improve infiltration and slow down runoff)
- Next step, model implementation of potential solutions to the problem (storm tanks, infiltration drainages, improve pipe system)

Thanks for your attention

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