Modelling the Transport of Contaminants in Urban Flood Flows

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Health Risks of Urban Floods

- Urban floods (especially those in areas with combined sewers) contain high levels of pathogens and other harmful bacteria
- Direct and indirect contamination risk, risk to vulnerable sites
- Is it possible to develop modelling capability to include this?
Presentation at ICUD 2017 from Head of Innovation at DHI

- Contaminant transport model added to flood model
- Calibration/Verification data?
Considerations for a (accurate) urban flood infection risk model

• Initial distribution in the catchment (temperature/time of year.....)
• Transport mechanisms (sediments/solutes)
• Urban runoff
• Reaction / degradation in the sewer
• Sewer hydraulics and transport (sediments/solutes)
• Transport through gully/manhole

• Exchange to surface (complex hydraulics)
• Survival/growth in urban floodwater
• Transport in urban floodwater (sediment/solute)
• Effects of turbulence on bacteria
• Fate and lifespan on the surface (environmental factors)
• .......

Solute Transport Model for Urban Flood Flows

• Develop the facility to track the concentration of a soluble tracer as it moves from sewer to surface
  – Concentration of tracer can be derived from measured light intensity under illumination

• Test a simple transport only model in shallow urban flood flow
  – No chemical/biological reactions
  – Mixing and transport processes on the surface only
  – Range of hydraulic and urban surface setups
Concentration Measurements

- Technique to measure depth averaged concentrations of a tracer over the floodplain
  - Green light to fluoresce dye
  - Non uniform illumination – Calibration required for each pixel

\[ y = 0.999x \]
\[ R^2 = 0.998 \]
Dynamic Examples

- Feasible technique for concentration measurement if uniform lighting maintained
Velocity + Concentration

• Feasible to conduct PIV and Conc. together

  • Initial Image

  • Ratio of component colours used to identify particles in image

  • Particles have been removed from image BUT shadow are harder to remove
    • a more diffuse light source helps
The illuminated facility
The Source (Sewer)

• Options.....
  – Steady Surcharge rate, Steady Concentration
  – Steady Surcharge Rate, Unsteady Concentration
  – Unsteady Surcharge rate, Steady concentration*
  – Unsteady Surcharge rate, Unsteady concentration
Measurements on the Facility

Unit discharge = 0.7l/sm, Surcharge 3l/s,
Transport and Mixing Processes
Modelling Pollutant Transport

• Developed a model based on the 2D ADE
  – Surface flow, not manhole
  – Couple with hydraulic model

• Next step is to calibrate against data from facility
  – Velocity data (from hydraulic model)
Conclusions

• Increasing awareness of the health impacts of urban flooding
• Some health impact models are now under development
• This work has developed a facility to examine solute transport in shallow flows
• Future work to calibrate the ADE model
• Followed by......