Workshop with editors on application of Australian Rainfall and Runoff (ARR2016) in Urban Areas Examples

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With
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Brownfield example

Collaboration with Mikayla Ward

- Highly urbanised catchment in the Sydney CBD – 1.6 km^2
- Pit and pipe network with overland flow conveyed on roads
- Evaluating distributed flooding
- Use coupled 1D/2D hydaulic model
- Combined hydrology and hydraulic models

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- Overland flow is a major hazard that needs to be managed

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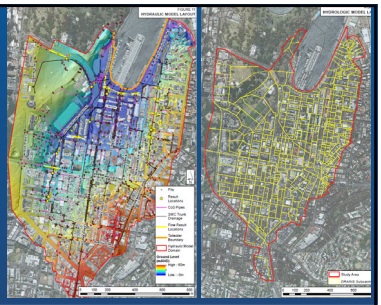
Tested 3 methods

1. Hydrology model for small catchments – inflow to 1D/2D hydraulic model
2. Concentrated direct rain applied to polygons of different land surfaces with losses – inflow to 1D/2D hydraulic model
3. Direct rain less losses on grid (2 m X 2 m)



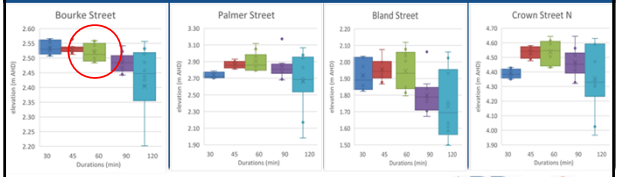
Brownfield example

- Data Hub
  - Rural IL = 28 mm, CL = 1.6 mm/hr, median 1% AEP 1 hr pre-burst = 1.1 mm
- Surfaces
  - 75% EIS, 20% pervious, 5% indirectly connected impervious surfaces
- Urban Burst losses (Ch. 3, Book 5 & local data less pre-burst rain)
  - EIA: IL = 0.4 mm, CL = 0 mm/hr
  - ICIA: IL = 16.1 mm, CL = 2.5 mm/hr
  - Pervious: IL = 26.8 mm, CL = 1.6 mm/hr
- Pit blockage factors from Section 5.5, Book 9

Sag Inlet Pit	
Kerb Inlet	80%
Grated Inlet	50%
Combination	Assume Grate 100% blocked
On-grade Inlet Pit	
Kerb Inlet	80%
Grated Inlet	60%
Combination	90%

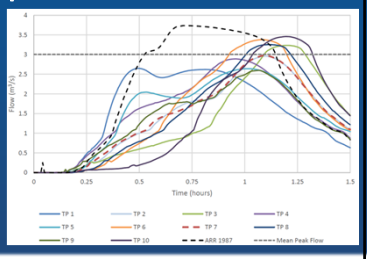
Brownfield example

- Rainfall ensembles used in combined hydrology and hydraulic model to select critical duration
  - Based on mean flood elevations
  - Spatial variation in critical duration – chose 60 minutes as best fit



Brownfield example

- Hydrographs from 1% AEP 60 minute rainfall ensembles compared to ARR87 single pattern at Bourke Street
  - Different runoff patterns and peak to ARR87
  - Chose Temporal Pattern 7 as the design storm



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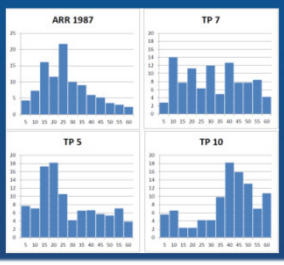
Temporal Pattern Comparison

TP5 below median discharge at Bourke St

TP10 above median discharge at Bourke St



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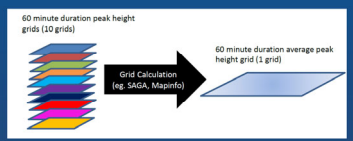
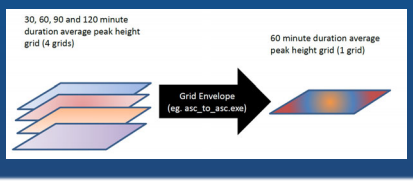
Average (mean) Grid Calculation



Tip: make sure you account for edge grids that are only wet in a some ensembles

Envelope grids



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Difference in level between the selected temporal pattern (TP7) and the average grid

Less than -0.25	0.0%
-0.25 to -0.1	0.0%
-0.1 to -0.05	0.8%
-0.05 to 0.05	99.1%
0.05 to 0.1	0.0%
0.1 to 0.25	0.0%
Greater than 0.25	0.0%

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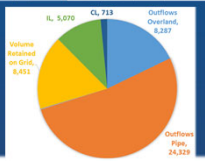
- Buildings were nulled in the direct rain on grid method
  - Elevation raised by 2 m with n = 0.015
- Buildings were separate polygons in concentrated direct rain model
- Volume check undertaken in upper catchment to define catchment storage
  - Total rain + inflows – losses – outflows
  - 18% (15.4 mm) retained on grid due to topography

Type	Catchment Area (m²)	IL (mm)	CL (mm/hr)
100% Pervious	22,508	26.9	1.6
100% Impervious	102,607	0.4	0.0
EIA	133,909	0.4	0.0
ICIA	34,549	16.14	1.6
ICIA (Buildings)	234,630	16.14	1.6
AVERAGE LOSS		9.6	0.9
TOTAL (m²)	528,202		



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- Need to correct direct rain model by reducing assumed losses
  - 5% acceptable error
  - This will increase pipe and surface flows
- Decrease assumed Initial losses
  - Outflows changed from 62 mm to 74 mm for concentrated direct rain
  - Outflows changed from 64 mm to 74 mm for direct rain on grid
- Total catchment storage (Initial losses) was 16 mm using direct rain methods with volume check
  - 15 mm storage (IL) in traditional hydrology and hydraulic model
  - Thus corrected direct rain model is OK

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Should also use sensitivity tests:

- No accounting for rainfall lost to depression storage
- Accounting for depression storage loss by reducing the initial loss. Apply direct rainfall with initial loss, less the average depth on grid
- Accounting for depression storage using a restart file, which reapplied the conditions from the last time step to the model. Direct rainfall applied with the initial conditions adopted from the final time step of the initial simulation

Direct rain models should also be compared to traditional hydrology and hydraulic models

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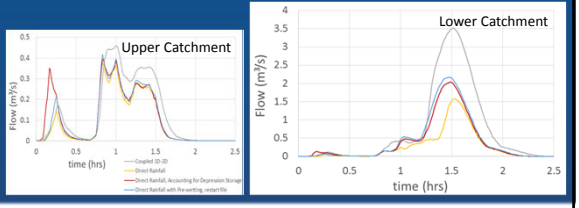
Uncorrected direct rain methods under-estimate surface flows

- Improved results for corrected models



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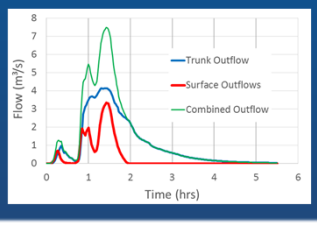
Surface flows are a significant proportion of urban hydrology



Tips

- Running ensembles through hydraulic model
- Make sure you account for grid cells not wet in some ensembles when taking average
- Check volume of runoff
- Find an event close to average grid results for simple development assessments