Applying a hierarchy of losses, pre-burst rainfall, rainfall ensembles, storm losses and climate change

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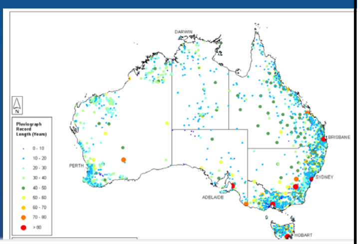
Storms and Losses becoming more realistic and defendable

aspect	ARR 1987	ARR 2016	Future
Storms volumes	Bursts only	Quasi-storms	Complete storms
Number	1	10	Large ensembles
Patterns	AVM - unrealistic	observed	observed
Pre-burst rainfall	NA	Estimated from nearby data	Complete storms include pre-burst
Post burst rainfall	NA	NA	Complete storms include post burst
Interaction of pre-burst and IFD	NA	Medium pre-burst	Can be calculated
Losses	No data	Scant data	Some data ?

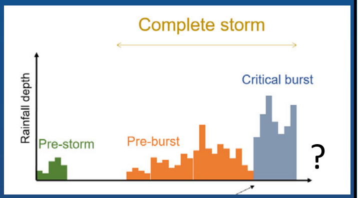
IFD 2016

- Significantly more continuous rainfall gauges
- Robust pooling of data



Storms becoming more complete

- Storm volumes more realistic
- Approach is closer to real system

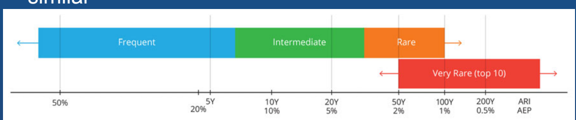


All data sampled for IFD, Patterns and Pre-burst

Region	Number of Gauges	Number of Station Years	Number of Events	Average Number of Events per Station Year
Southern Slopes (Tasmania)	110	2,954	3,477	1.18
Southern Slopes (mainland)	356	8,536	20,581	2.41
Murray Basin	233	6,316	18,399	2.91
Central Slopes	118	2,767	7,167	2.59
East Coast South	331	8,067	19,856	2.46
East Coast North	210	5,187	12,123	2.34
Wet Tropics	99	2,474	5,437	2.20
Monsoonal North	211	5,054	12,287	2.43
Rangelands West	93	2,334	5,391	2.31
Rangelands	226	5,561	12,618	2.27
Flatlands West	349	9,113	26,402	2.90
Flatlands East	56	1,401	3,450	2.46

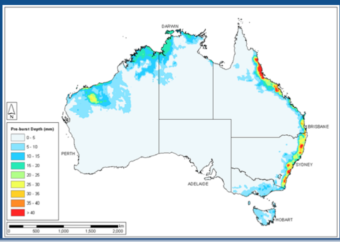
Temporal Patterns

- 10 temporal patterns are provided for each of the four categories of severity
- Temporal patterns should be used to derive floods in similar



Pre-burst

- Only an issue in some locations
- Generally medium pre-burst is a reasonable value
- Sampling from distribution is a good idea when ratio of 90% to 50% is high



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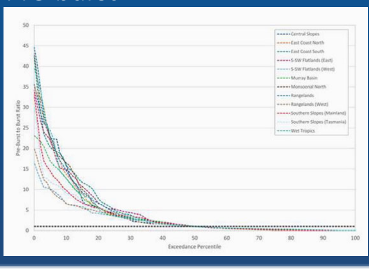
Pre-burst

Medium preburst is not representive when

- 90% /50% ratio is high
- 50% value is significant



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Pre-burst Rainfall and Loss Equation Ch. 6

- Use median pre-burst rainfall from ARR Data Hub
- Burst loss = storm losses – pre-burst rainfall (Burst Loss ≥ 0)
- Use one hour pre-bust rainfall for storm burst durations of less than one hour

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Hierarchy of Assumptions about Urban Losses and Connectivity Ch. 6

- ***Rural and regional loss assumptions should not be a default assumption for urban areas!***
- Hierarchy of Urban Loss assumptions:
  1. Use local losses based on GIS investigations, local knowledge and observations (Losses derived at a regional scale are not local losses – use local losses in small scale models)
     a) Note that a well constructed model with adequate spatial scale should account for effective impervious area and connectivity effects
  2. Regional losses (Book 5, Ch 3.4, 3.5):
     a) Impervious area: IL <1 mm, CL: 0 mm/hr; EIA: IL: 1 -2 mm, CL: 0 mm/hr; Pervious area ≈ rural losses etc
  3. Rural losses: 60% - 80% of rural IL losses etc

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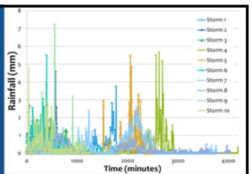
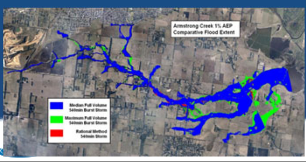
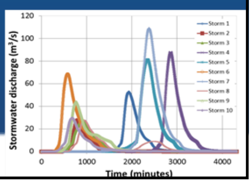
"New" tools Ch. 6

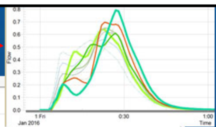
- Ensembles of rainfall and temporal patterns
  - Storm bursts
  - Quasi- Complete storms
  - Based on local reality
- New IFDs
- Pre-burst
- RFFE
- Monte Carlo testing
- Continuous simulation and rainfall

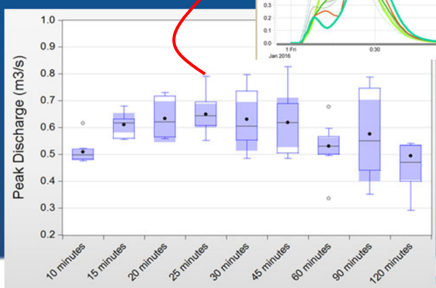






Hydrology Ch. 6





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Climate Change

- Five factors vulnerable to change:
  - IFD Rainfalls
  - Temporal & spatial patterns
  - Continuous rainfall sequences
  - Antecedent conditions and baseflows
  - Compound extremes
- Climate futures exploration tool provides useful summary of impact on selected factors:

https://www.climatechangeinaustralia.gov.au/en/climate-projections/climate-futures-tool/projections/

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Climate Change

- Currently, GCMs provide robust estimates of the impacts on temperatures, but impacts on rainfalls, particularly rainfall intensities, is far more uncertain.
- Evidence for impacts on temporal and spatial patterns of rainfall is emerging, and indicates that these patterns will intensify
- In practice, the only factors that are easiest to quantify at present are the impacts of climate change on rainfall IFDs and sea levels.
- Other factors need careful thought and investigation

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Climate Change

- Book 1 Ch 6 provides guidance on decision process to be used for assessing the impacts of climate change on floods:
  - Effective service life of the asset
  - Consequence of failure and costs of retrofitting
  - Assess impacts on IFD:

$$I_p = I_{ARR} \times 1.05^T$$

- See worked example in Section 6.4

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Interim Climate Change Factors

Values are of the format temperature increase in degrees Celcius (% increase in rainfall)

	RCP 4.5	RCP6	RCP 8.5
2030	0.719 (3.6%)	0.739 (3.7%)	0.822 (4.1%)
2040	0.925 (4.6%)	0.915 (4.6%)	1.119 (5.6%)
2050	1.123 (5.6%)	1.085 (5.4%)	1.449 (7.2%)
2060	1.271 (6.4%)	1.294 (6.5%)	1.865 (9.3%)
2070	1.394 (7.0%)	1.526 (7.6%)	2.333 (11.7%)
2080	1.477 (7.4%)	1.778 (8.9%)	2.776 (13.9%)
2090	1.527 (7.6%)	2.009 (10.0%)	3.21 (16.1%)

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Climate Change

- Need to carefully consider the latest research on climate change
- For example; latest research shows links between urban heat island effects and increased rainfall intensity

Wasko, C. and A., Sharma, (2015), Steeper temporal distribution of rain intensity at higher temperatures within Australian storms. Nature Geosciences. 8, 527–529
Guerreiro S.B., H.J., Fowler, R., Barbero, S., Westra, G., Lenderink, S., Blenkinsop, E., Lewis and X., Li, (2018), Detection of continental-scale intensification of hourly rainfall extremes, Nature Climate Change, 1-5

ARR Australian Rainfall & Runoff