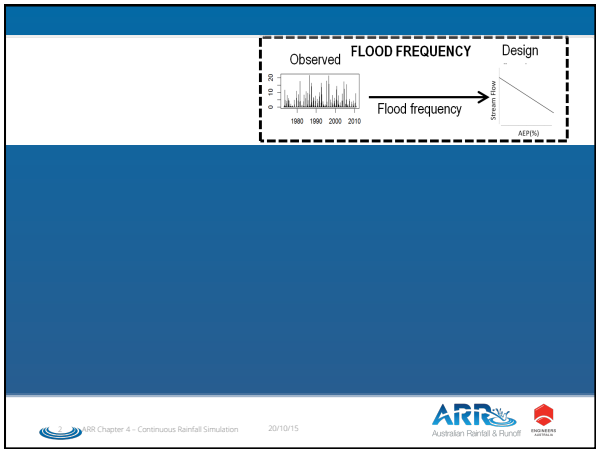
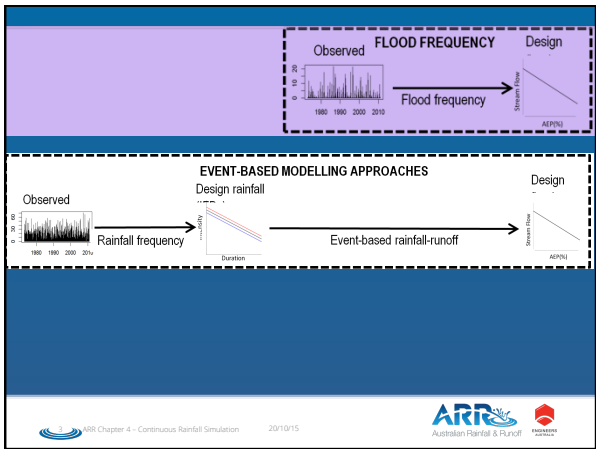
ARR Revision Project 4
Continuous Rainfall Simulation[1]

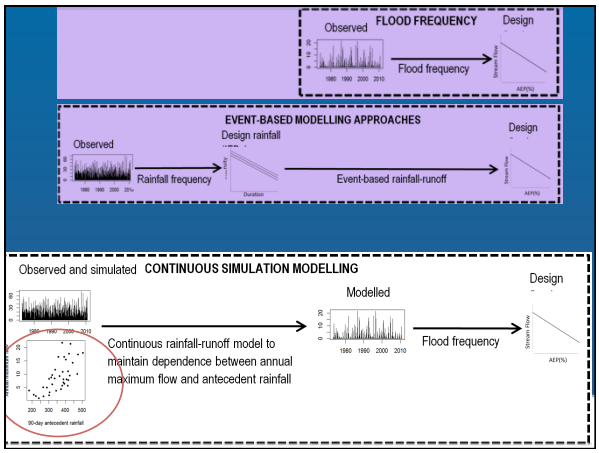
Ashish Sharma – a.sharma@unsw.edu.au
Civil and Environmental Engineering, UNSW

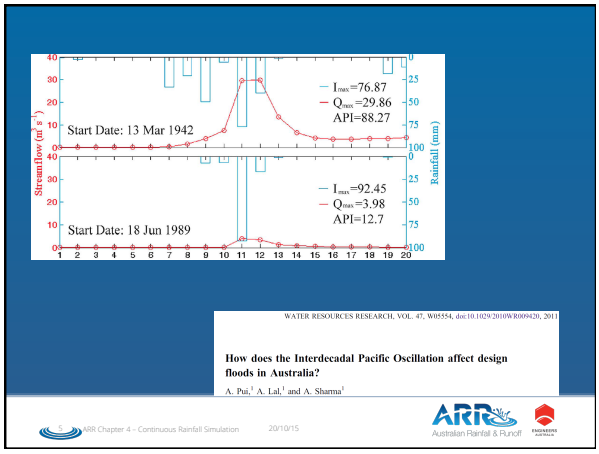
[1]Authored by Sharma, Srikanthan, Mehrotra, Westra, with considerable assistance from Woldemeskel, Jha, Brady, Li, Wasko, Pui
Funding support: IEAust, ARC

Australian Rainfall & Runoff





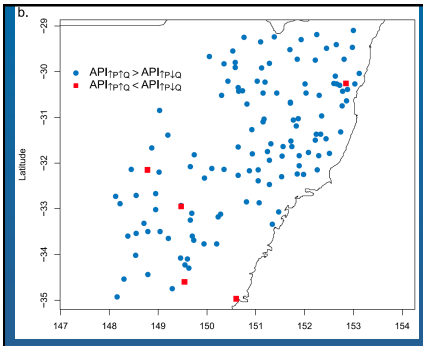




WATER RESOURCES RESEARCH, VOL. 47, W05554, doi:10.1029/2010WR009420, 2011

How does the Interdecadal Pacific Oscillation affect design floods in Australia?

A. Pui,[1] A. Lal,[1] and A. Sharma[1]



WATER RESOURCES RESEARCH, VOL. 47, W05554, doi:10.1029/2010WR009420, 2011

How does the Interdecadal Pacific Oscillation affect design floods in Australia?

A. Pui,[1] A. Lal,[1] and A. Sharma[1]

IPO/ENSO influences Antecedent Rainfall AND Extreme Rainfall

Implies – Extreme Rainfall NOT INDEPENDENT of Antecedent Rainfall

Implies – Event based design flood approach without factoring in DEPENDENCE between extreme and antecedent rainfall is not right

SOLUTION? Generate full sequences containing extremes and antecedent rainfall

ALSO – generating such sequences for warmer climate allows estimation of change in design flood for future conditions

WATER RESOURCES RESEARCH, VOL. 47, W05554, doi:10.1029/2010WR009420, 2011

How does the Interdecadal Pacific Oscillation affect design floods in Australia?

A. Pui,[1] A. Lal,[1] and A. Sharma[1]

Continuous Rainfall Simulation

PART 1 - Daily Rainfall Simulation
- Extremes
- Antecedent
- Seasonality
- Useable anywhere!

- Nested-TPM (N-TPM) – e-Water Toolkit Stochastic Climate Library
- Regionalised MMM (RMMM) – Hydrology@UNSW Software

Continuous Rainfall Simulation

PART 2 - Sub-daily Rainfall Simulation
- Extremes
- Antecedent
- Seasonality
- Useable anywhere!

- DRIP – e-Water Toolkit Stochastic Climate Library
- Regionalised MOF (RMOF) – Hydrology@UNSW Software

Continuous Rainfall Simulation

PART 3 - Sub-daily Rainfall Simulation to Match Target IFD

Aim is to post-process continuous rainfall sequences such that their derived IFDs are similar to a specified target (BoM IFDs)

Can be used with any continuous rainfall simulator Hydrology@UNSW Software

How to Regionalise?

Regionalised daily rainfall generation - identification of nearby stations

For any location of interest (the "target" location), identify the probability that each of the daily rain gage stations in Australia is statistically similar using the logistic regression coefficients provided in Mehrotra et al (2012).

For each attribute, rank each of the these stations from highest to lowest in terms of the probability that the rainfall at both stations are statistically similar, and calculate the average rank for each station across all rainfall attributes. Low values of the rank therefore represent stations with a high probability of having similar rainfall patterns to the target site.

Select the *S* lowest-ranked stations to represent the set of "statistically similar nearby stations" for inclusion in the daily rainfall generation model.

Calculate the weight associated with each nearby stations using the following:

$$wi = 1/ri \; / \sum_{k=1}^{s} 1/rk$$

where the weight wi represents the probability that the i^{th} station will be selected and ri represents the associated rank.

How to Generate?

Regionalized daily rainfall generation – implementation

Identify nearby stations and calculate the weight associated

Calculate the average annual rainfall, A^s, at the identified nearby stations and, the average annual rainfall at the target station, A^o, using a spatially interpolated map of total annual rainfall across Australia.

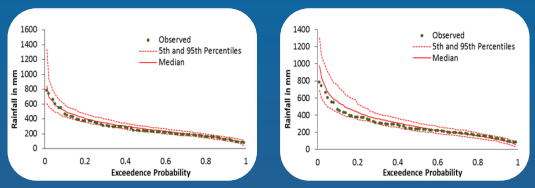
At each identified nearby location, for all calendar days of the year, calculate the parameters of the daily rainfall generation model

At a given day, generate a uniformly distributed random number and probabilistically identify a nearby station. Generate rainfall using the parameters of the identified station

Rescale the generated daily rainfall by multiplying it with the ratio A^o / A^s

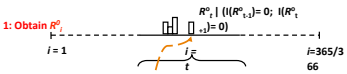
Move to the next day in the generated sequence and repeat the above steps

Example – Alice Springs (daily)

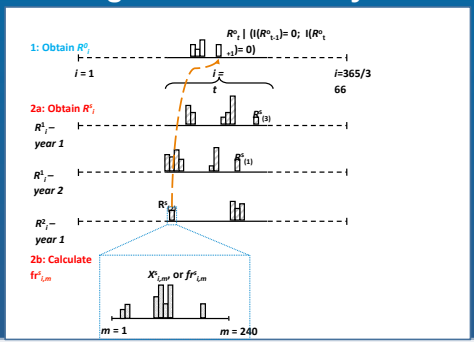


At-site Regionalised

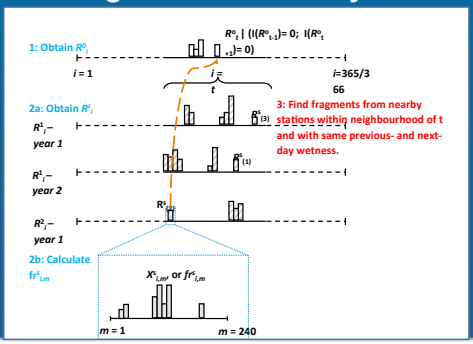
How to generate sub-daily?



How to generate sub-daily?

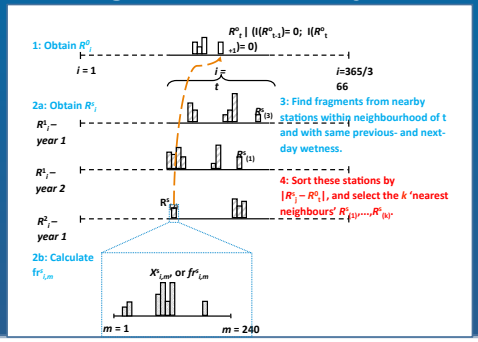


How to generate sub-daily?

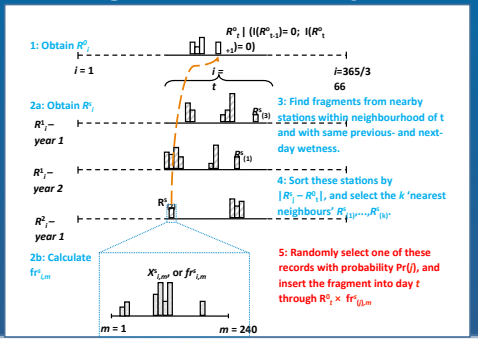


3: Find fragments from nearby stations within neighbourhood of t and with same previous- and next-day wetness.

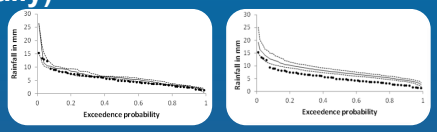
How to generate sub-daily?



How to generate sub-daily?

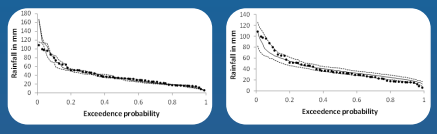


Example – Alice Springs (sub-daily)



6m – Obs

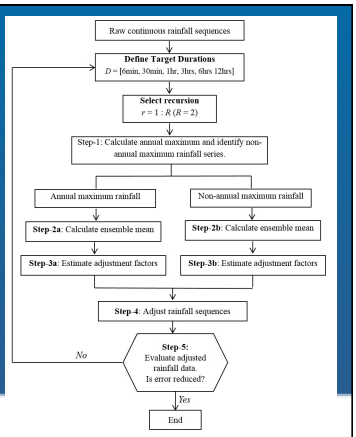
6m – RMOF



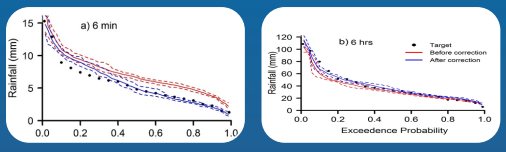
6h – Obs

6h – RMOF

How to match design IFD?



Example – Alice Springs (sub-daily)



6m 6h

Climate change implications?

- Daily sequences:
  - Antecedent conditions likely to change
  - Some change in extremes
  - Can use Stochastic Downscaling version of RMMM for generating future daily rainfalls

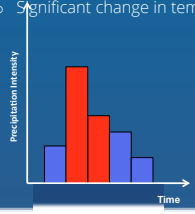
Mehrotra, R., and A. Sharma (2010), Development and Application of a Multisite Rainfall Stochastic Downscaling Framework for Climate Change Impact Assessment, *Water Resources Research, 46, doi:10.1029/2009WR008423.*

Climate change implications?

- Subdaily sequences:
  - More change in extremes – see ARR chapter on Climate Change
  - Significant change in temporal patterns

Climate change implications?

- Subdaily sequences:
  - More change in extremes – see ARR chapter on Climate Change
  - Significant change in temporal patterns



Wasko, Sharma, *Nature Geoscience,* 2015

Climate change implications?

- Subdaily sequences:
  - More change in extremes – see ARR chapter on Climate Change
  - Significant change in temporal patterns
- Possible solution – Select fragments in RMOF conditional to predicted future temperature

Westra, S., J. P. Evans, R. Mehrotra, and A. Sharma (2013), A conditional disaggregation algorithm for generating fine time-scale rainfall data in a warmer climate, *Journal of Hydrology, 479, 86-99.*

To wrap up…

- Regionalised Daily Rainfall Generation anywhere in Australia
  - N-TPM
  - RMMM
- Sequences simulate extremes + antecedents well
- Regionalised sub-daily Rainfall Generation anywhere in Australia
  - DRIP
  - RMOF
- Sequences simulate extremes and can be tailored to

Contacts

Email: arr_admin@arr.org.au
Website: www.arr.org.au

General:
James Ball – ARR Editor
Mark Babister – ARR Project Manager
Monique Retallick – ARR Project Engineer

Project 4: Continuous Rainfall Simulation
Project Team: Ashish Sharma, R. Srikanthan, Raj Mehrotra, Seth Westra

ARR Revision Project 4
Continuous Rainfall Simulation[1]

Ashish Sharma – a.sharma@unsw.edu.au
Civil and Environmental Engineering, UNSW

[1]Authored by Sharma, Srikanthan, Mehrotra, Westra, with considerable assistance from Woldemeskel, Jha, Brady, Li, Wasko, Pui
Funding support: IEAust, ARC