

Australian Rainfall & Runoff Revision Research Projects

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Australian Rainfall and Runoff
A guide to runoff estimation

AGENDA

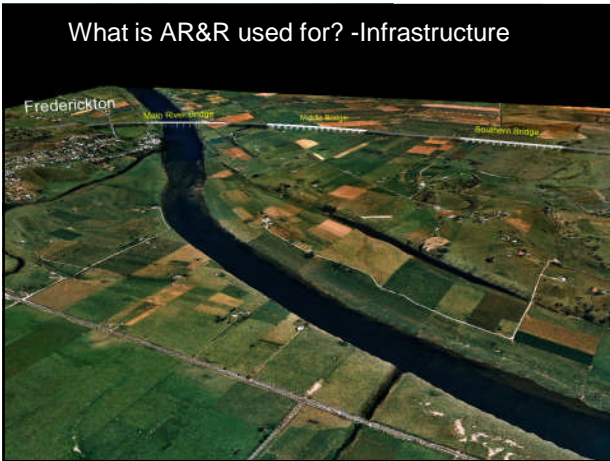
- Current Status
- Update Program
- Project Update
- Administration

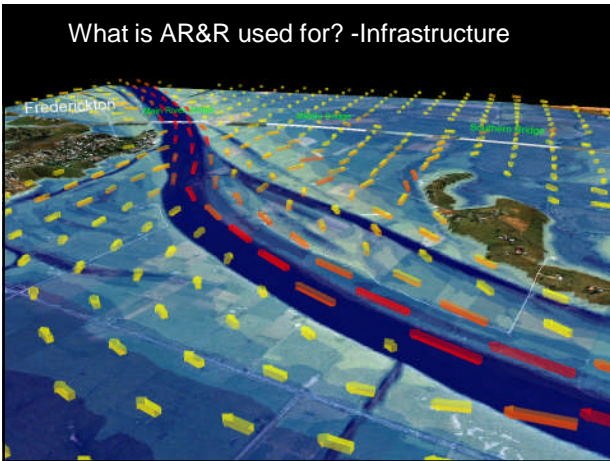
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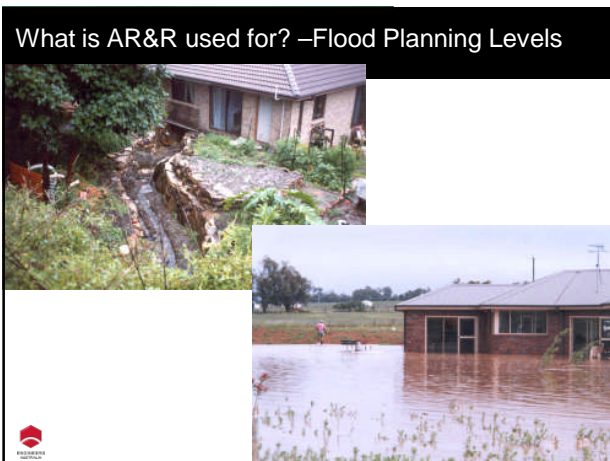
WHAT IS AR&R?

- What is AR&R?
 - Guideline for the calculation of flows and flood behaviour
 - AR&R is not prescriptive
 - AR&R is a guideline document as the nature of hydrologic problems vary

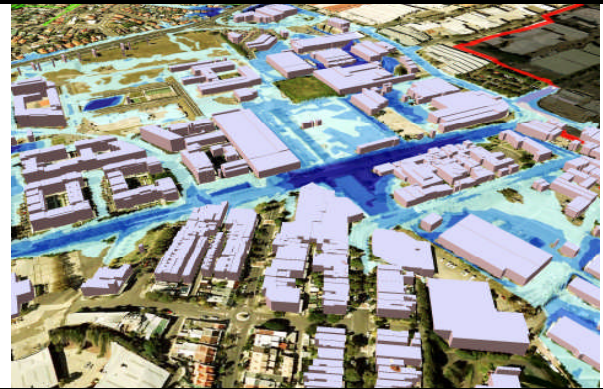
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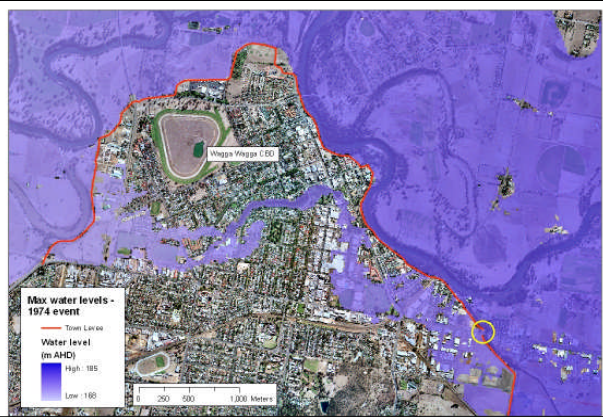




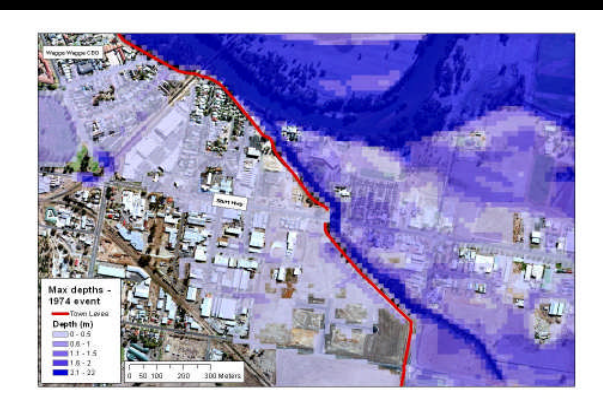
What is AR&R used for? –Urban Redevelopment

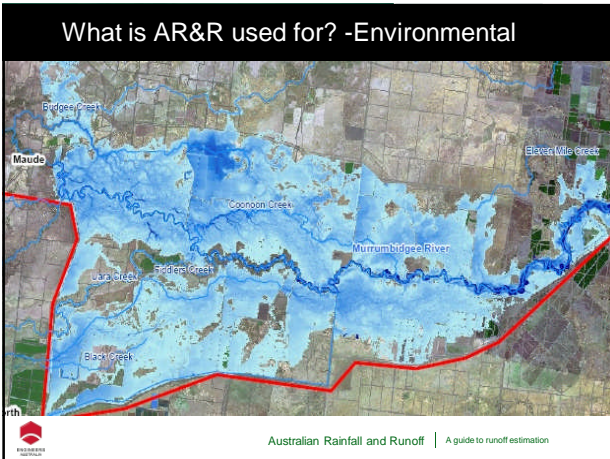


What is AR&R used for? –Protection



What is AR&R used for? –Protection







AR&R CURRENT STATUS

Points to note are


- Over 20 years since last revision with only one chapter revised in that period.
- Significantly longer records now available.
- IFD data over 25 years old.
- Written before a computer on every Engineers desk
- Climate change concerns

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CLIMATE CHANGE AND ARR

ARR87


- It should be noted that no consideration has been given to the long term effects of climatic change, a topic which is receiving increasing attention in the scientific literature.
- "Many important economic and social decisions are being made today on long term projects based on the assumption that past climatic data, without modification, are a reliable guide to the future. This is no longer a good assumption since the increasing concentrations of greenhouse gases are expected to cause a significant warming of the global climate in the next century. It is a matter of urgency to refine estimates of future climate conditions to improve these decisions."
- As no reliable estimates of climatic change are available, it has been assumed that the statistical characteristics of heavy rainfall and floods remain constant throughout the design life of projects.

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CLIMATE CHANGE AND ARR

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- There is evidence that a progressive increase is to be expected in the temperature of the earth, the lower atmosphere and the oceans as a result of the "greenhouse effect"
- "One consequence of a global temperature rise would be an increase in mean sea levels, predominantly as a result of thermal expansion of the water in the oceans. A report prepared by Hoffman et al. (1983) has suggested a possible worldwide increase in sea levels of 0.25-0.40 m by the year 2025, and 0.50-1.50 m by 2080. Pittock has reported that the Villach Statement suggests the possibility of an increase of 0.80 ± 0.60 m by a few decades after 2030, whilst drawing attention to the very substantial uncertainties associated with such estimates."
- Accordingly, in the planning of substantial works of long expected service life, consideration must be given by the designer to the effects of sea level rises which may occur within the effective life span of the works.

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CLIMATE CHANGE AND ARR

1999 Extreme Flood Chapter Update


- At time of writing (1999) the Bureau of Meteorology do not consider the influence of climatic trends when preparing PMP estimates, and at present there is no known procedure for the reliable incorporation of climate change scenarios into flood estimates.
- Until better information becomes available, any assessment of the impact of climate change on flood risks is thus likely to be speculative and not suited for general design considerations.
- If, however, procedures are subsequently developed that are shown to have a scientifically credible basis then it may be appropriate to allow for the effects of climate change in the design process.

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AR&R REVISION

Basic reasons for revision include

- Changing focus of hydrologic design or analysis problem;
- Development of new approaches;
- Inconsistencies in existing recommended approaches; and
- Need to give explicit advice on Climate Change




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ARR REVISION

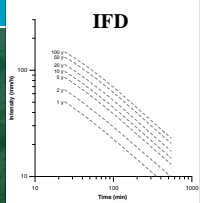
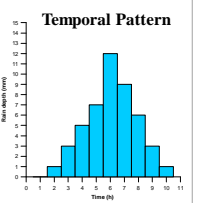
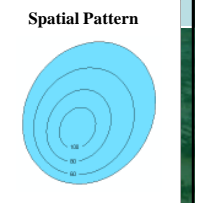
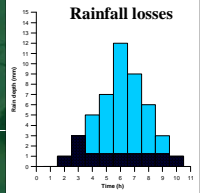


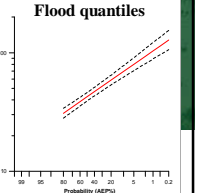
New problems include

- Environmental flows – estimation of flow magnitude during frequent events e.g. 1 year flow;
- System analysis rather than point analysis (failure analysis) – particularly relevant to urban systems, transport networks;
- How risk changes with Climate Change and
- Evacuation.




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Current design method

IFD 	Temporal Pattern 	Spatial Pattern 
Rainfall losses 	Models Rainfall Runoff Models  Hydrodynamic Models 	Flood quantiles 

CURRENT ISSUES


- Problems with AVM temporal patterns.
- Problems with Regional Methods.
- Spatial patterns not considered.
- Continuous simulation and Monte-Carlo simulation becoming practical but not considered.



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CURRENT ISSUES


- Increasing complexity in catchment modelling due to increasing complexity of problems.
- Flood management, e.g. Evacuation times, etc, not considered.
- Problem with estimating basin performance



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CLIMATE CHANGE ISSUES

- How will IFDs and other rainfall parameters change over time.
- Changing design performance over time
- Joint probability of rainfall and ocean levels (large % of population live in this zone) and change in dominate flood mechanism.




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AR&R FUNDING

Funds needed and their sources are

- EA contribution - \$6.46m
- Contributions totaling \$10.123m
 - Stage 1 (2008/09)
\$2M (from Dept of Climate Change)
 - Stage 2 (2009/10)
\$2M (from Dept of Climate Change and \$1M from BoM),
 - Stage 3 (2010/12)
\$6.123M (\$1M from BoM, \$1M from BoM inkind, remainder unknown)



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AR&R FUNDING

Stage 1 is due for completion at end of June 2009

- 10 of the 21 Projects will be started.
- 2 projects are scheduled for completion.

Stage 2 commences in July 2009 and is due to end in June 2010

- 19 of the 21 projects will have started.
- 5 Projects are scheduled for completion.



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ADMINISTRATION


- Steering Committee
 - Role: provide advice to Engineers Australia, in the discharge of its commitments and obligations under the Funding Agreement with the Department of Climate Change,
 - Explore funding options for Stages 2 and 3.
- Technical Committee
 - Role: provides technical advice on individual projects, including scope, program, proposal and review.
 - Each project is overseen by at least one member of Committee



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ADMINISTRATION

- Technical Committee
 - Chair Associate Professor James Ball, Editor ARR,UTS
- Members:
 - Mark Babister, MIEAust CPEng, Chair NCWE, WMAwater
 - Associate Professor, George Kuczera, University of Newcastle
 - Professor Martin Lambert, University of Adelaide
 - Dr Rory Nathan, SKM
 - Dr Bill Weeks, QLD DMR
 - Associate Professor Ashish Sharma, UNSW
 - Dr Michael Boyd, Technical Project Manager




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ARR RESEARCH PROJECTS

The projects are

1. Development of rainfall intensity-frequency-duration (IFD) information across the country
2. Spatial patterns of rainfall
3. Temporal patterns of rainfall
4. Continuous rainfall sequences at a point
5. Regional flood methods
6. Loss models for catchment simulation
7. Baseflow for catchment simulation
8. Use of continuous simulation for design flow determination
9. Urban drainage system hydraulics
10. Appropriate safety criteria for people
11. Blockage of hydraulic structures
12. Selection of an approach
13. Rational Method developments
14. Large to extreme floods in urban areas
15. Two-dimensional simulation in urban areas



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ARR RESEARCH PROJECTS

16. Storm patterns for use in design events
17. Channel loss models
18. Interaction of coastal processes and severe weather events
19. Selection of climate change boundary conditions
20. Risk assessment and design life
21. IT Delivery and Communication strategies




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ARR RESEARCH PROJECT 1

Development of rainfall intensity-frequency-duration (IFD) information across the country

The outcomes from this project will be

- Provision of updated information on current IFD relationships; and
- Provision of likely changes to IFD relationships arising from Climate Change.




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ARR RESEARCH PROJECT 1

Development of rainfall intensity-frequency-duration (IFD) information across the country

- [Update](#)




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ARR RESEARCH PROJECT 2

Spatial patterns of rainfall

The outcomes from this project are


- Development and testing of Areal Reduction Factors (ARFs);
- Development and testing of techniques for spatially distributing rainfall for both historical and design events; and
- An assessment of likely changes in the spatial pattern of rainfall arising from climate change.



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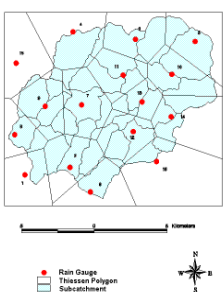
ARR RESEARCH PROJECT 2

- Current approaches to distributing rainfall are variable with differing degrees of accuracy.
- Current edition of ARR does not consider problem.




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ARR RESEARCH PROJECT 2

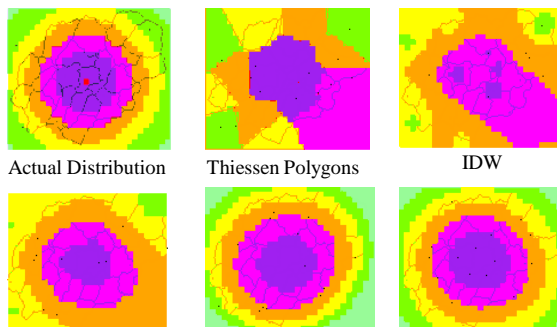


A number of alternative approaches have been applied to the Upper Parramatta Catchment.




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ARR RESEARCH PROJECT 2

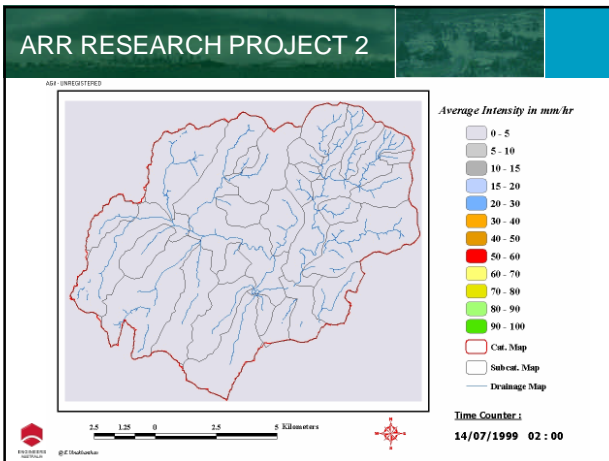


Actual Distribution Thiessen Polygons IDW

Kriging Polynomial Spline



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ARR RESEARCH PROJECT 3

Temporal patterns of rainfall

The outcomes from this project will be

- The development and testing of new temporal patterns of rainfall for use in design situations; and
- An assessment of likely changes in the temporal pattern of rainfall arising from climate change.

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ARR RESEARCH PROJECT 3


- Current approach in ARR is based on AVM.
- Known problems include
 - Internal bursts
 - Preference for particular patterns to be dominant
 - Need to filter patterns
 - Only bursts and not storms

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RAINFALL PATTERNS

Varga (2009) has been investigating this problem and has developed an alternative approach to the AVM patterns which is suitable for climate change consideration.

Application needs recognition that multiple storm patterns need to be considered.




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RAINFALL PATTERNS

Approach is

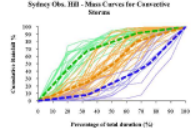
- Random walk generation – multiple alternative patterns;
- Storm characterisation – recognises patterns differ between generation mechanisms; and
- Considers total storm – removes issue of burst location in a storm event.



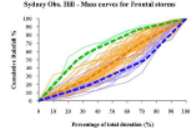
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RAINFALL PATTERNS

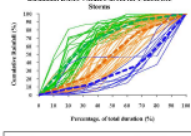
Sydney Obs. IRI - Mass Curves for Convective Storms



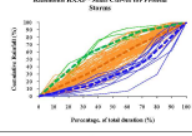
Sydney Obs. IRI - Mass curves for Frontal storms



Richmond R.A.S.P. - Mass Curves for Convective Storms




Richmond R.A.S.P. - Mass Curves for Frontal Storms

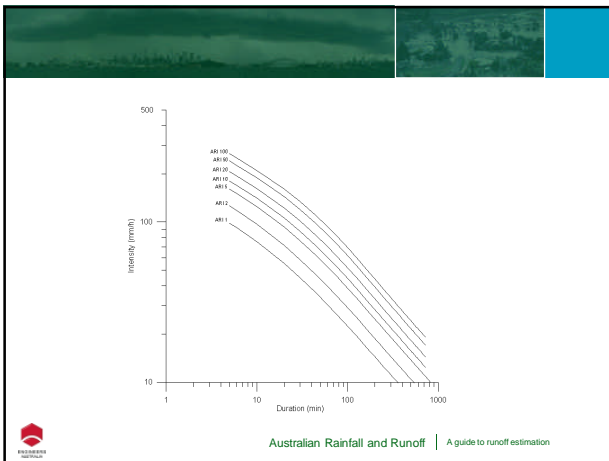


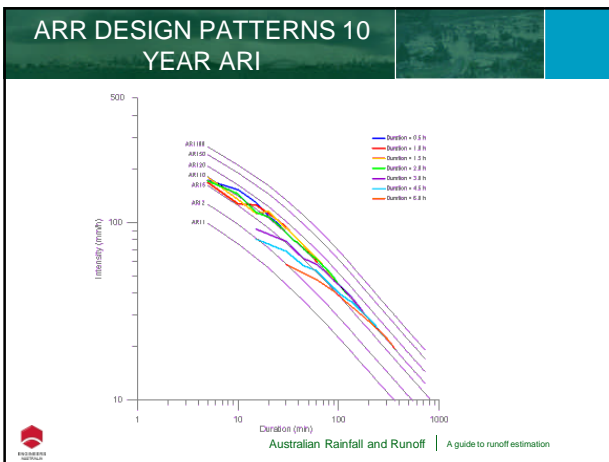
Legend:

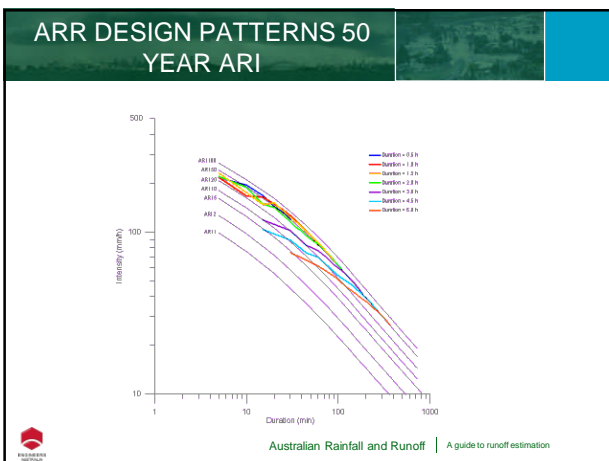
- Convective & Frontal (Observed) storms
- Convective & Frontal (Observed) storms
- Convective & Frontal (Observed) storms
- Convective & Frontal (Observed) storms
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- Convective & Frontal (Observed) storms
- Convective & Frontal (Observed) storms

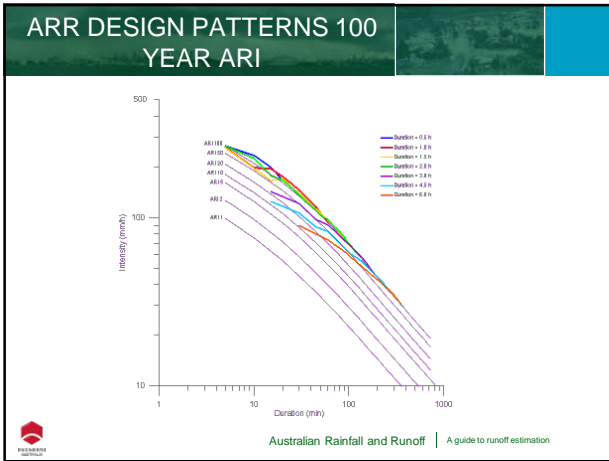


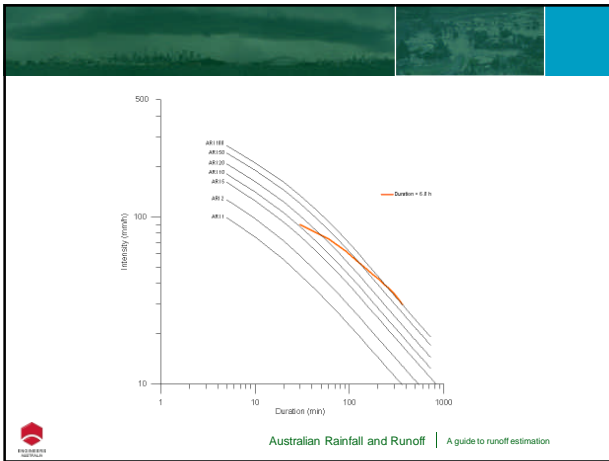
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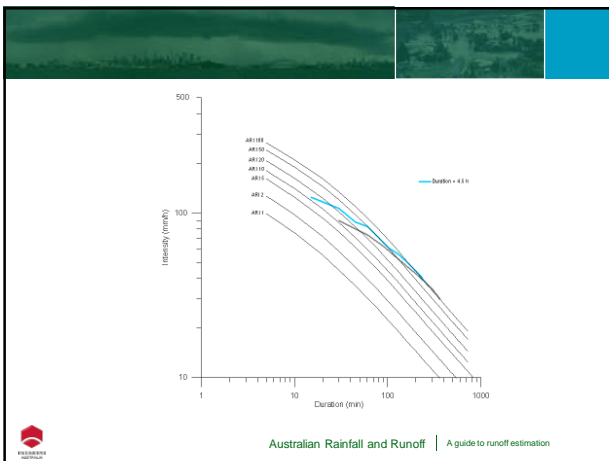


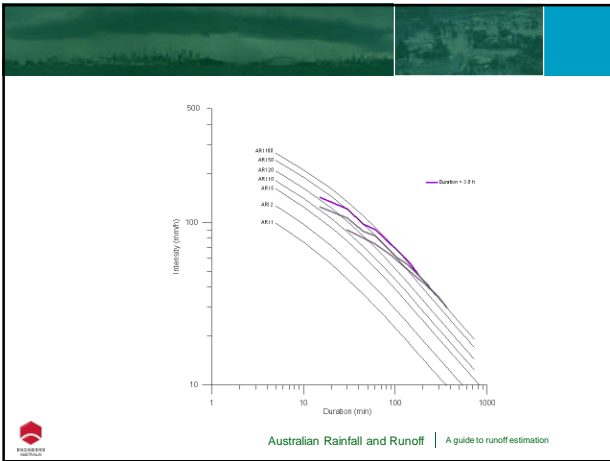


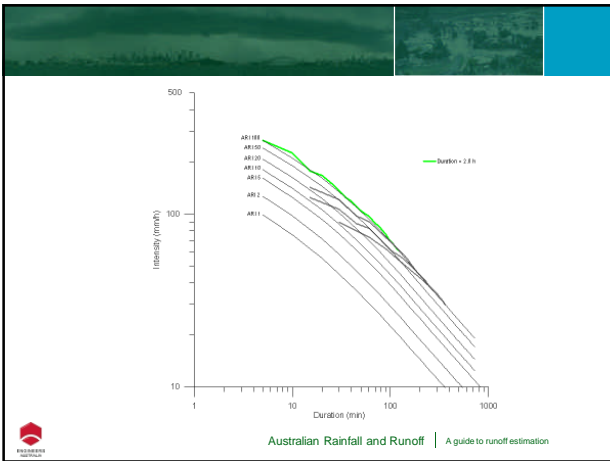


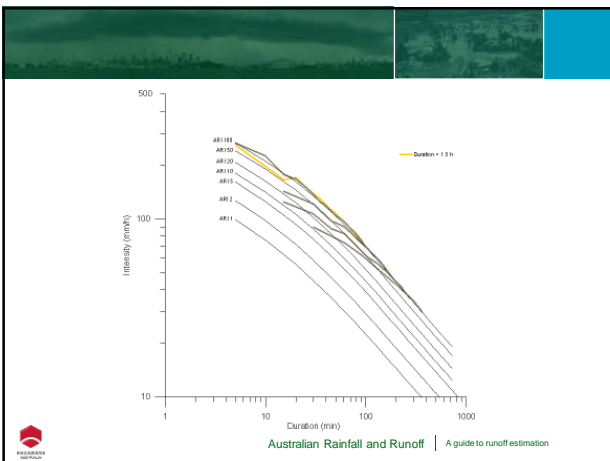


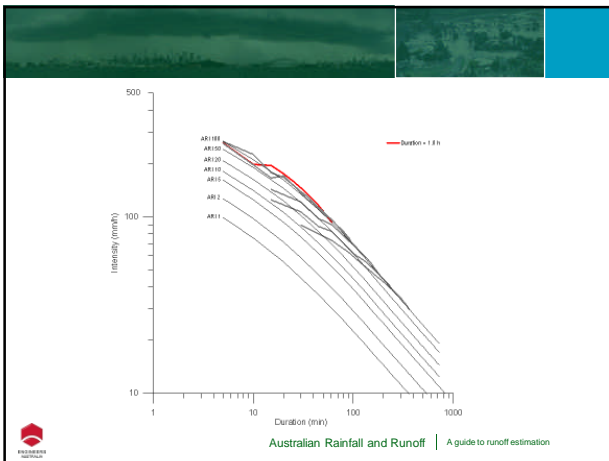


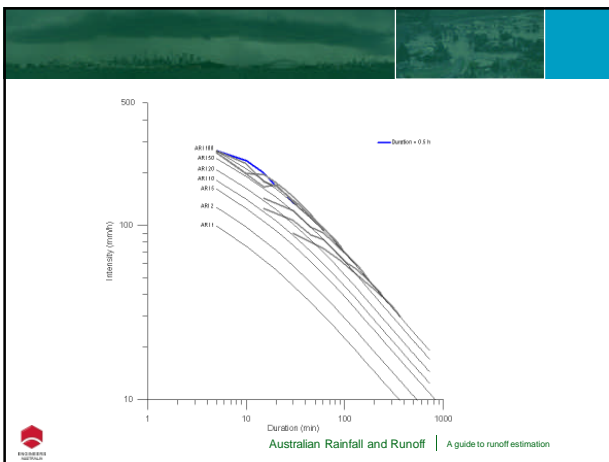


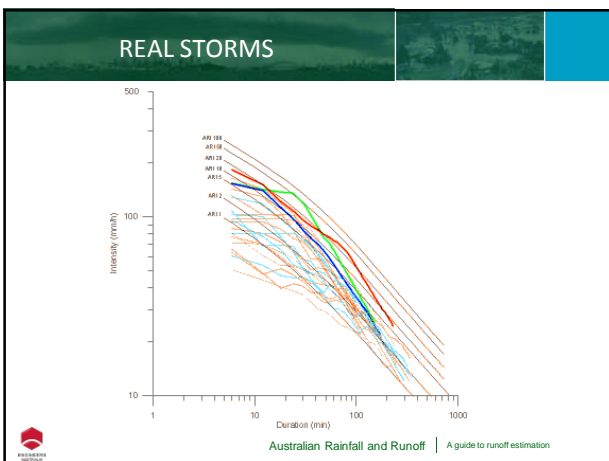


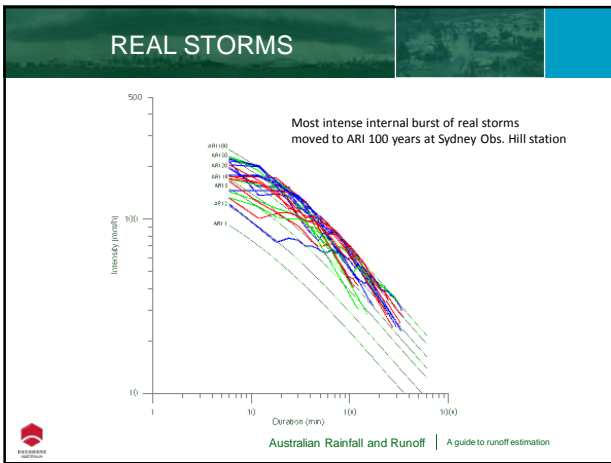


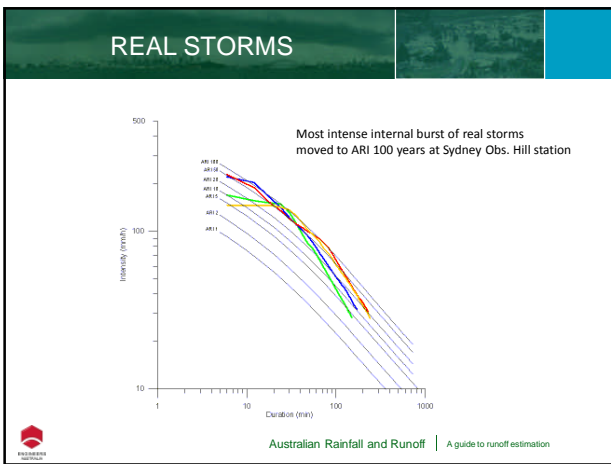


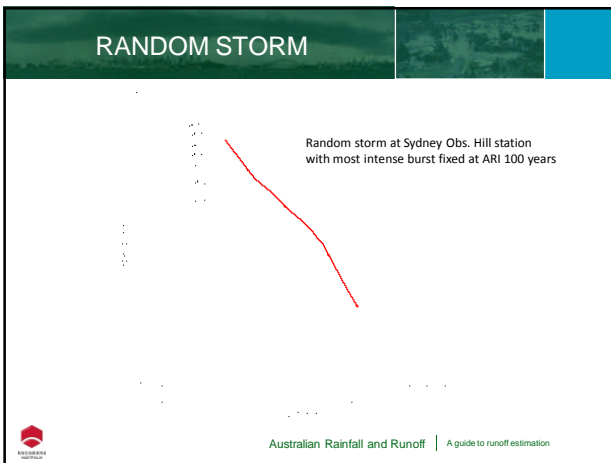


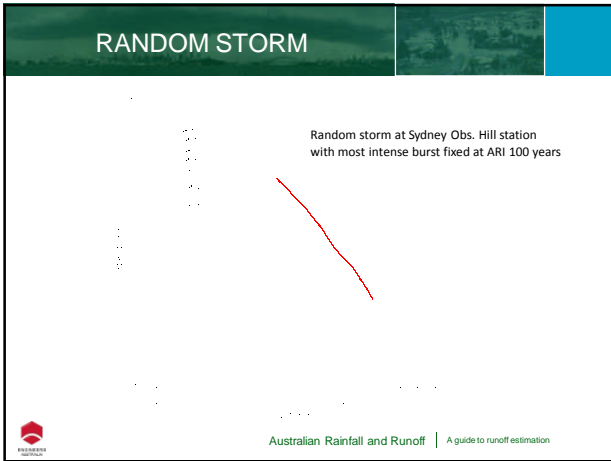


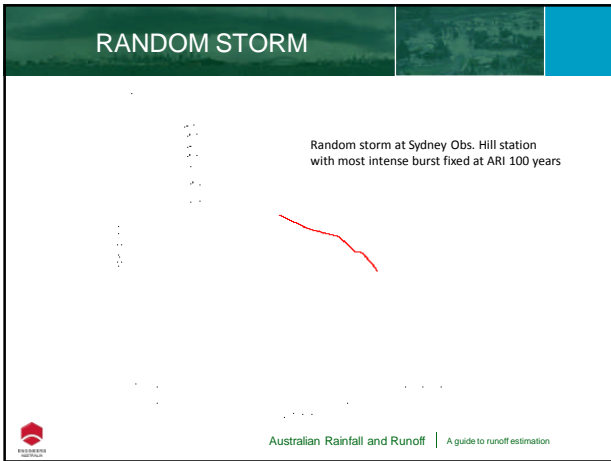


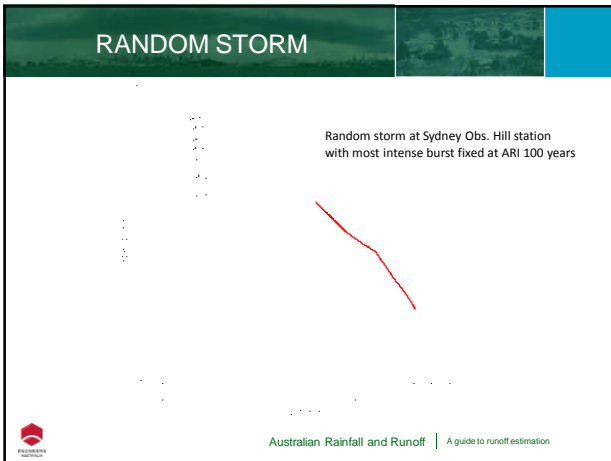


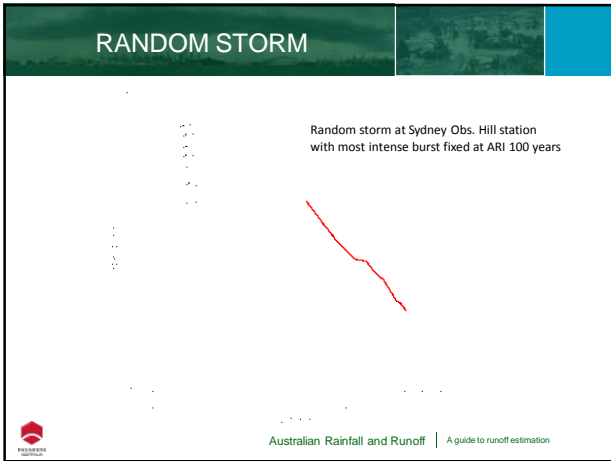


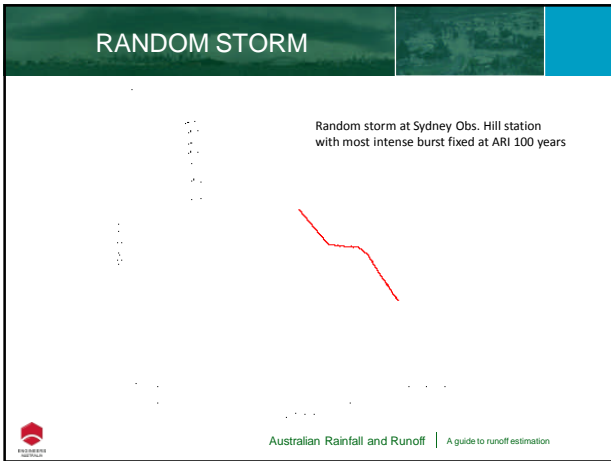


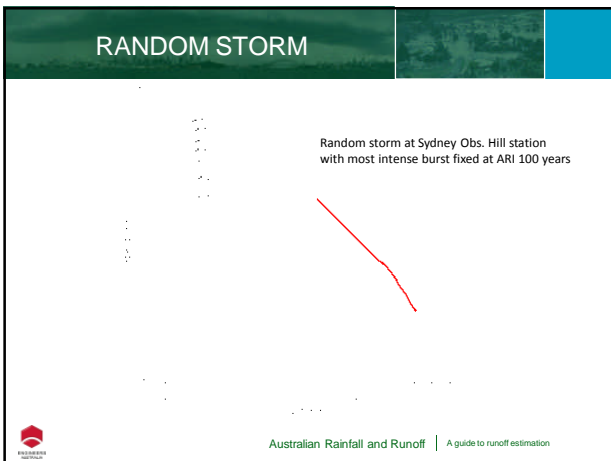


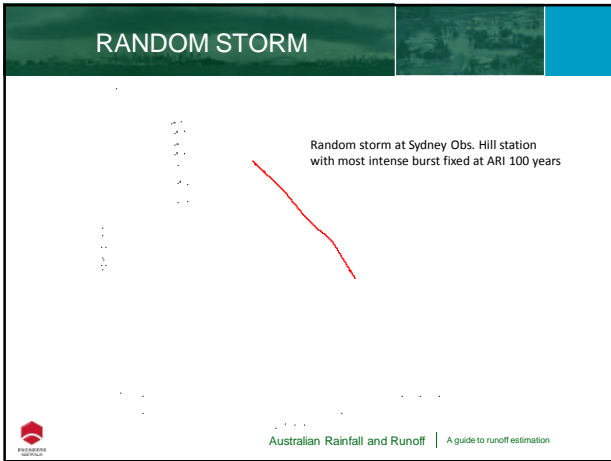


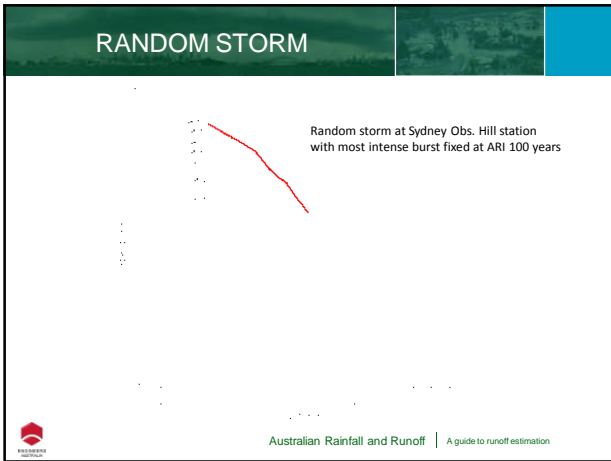


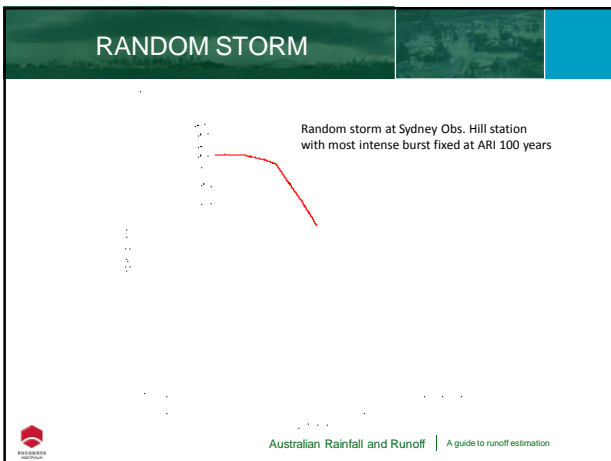


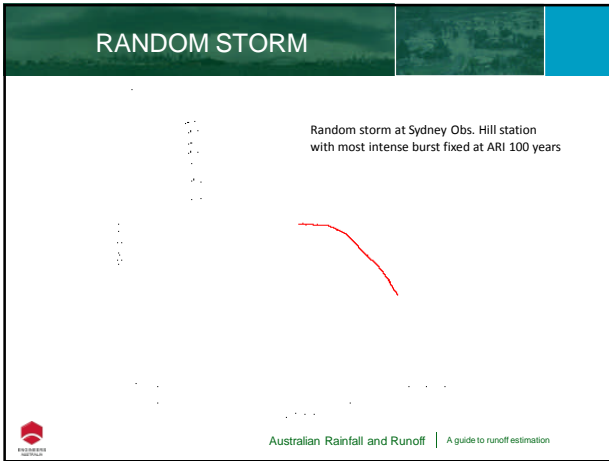


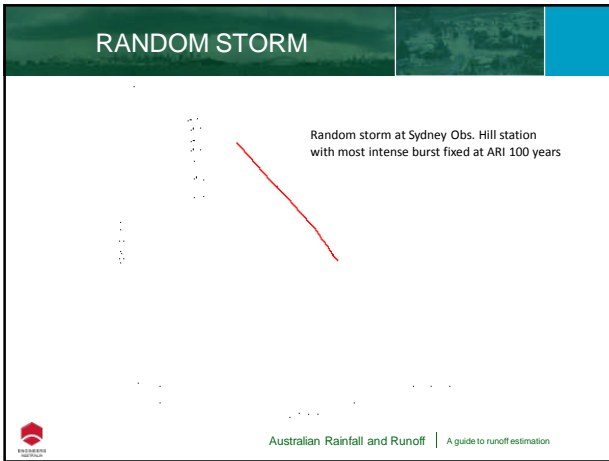


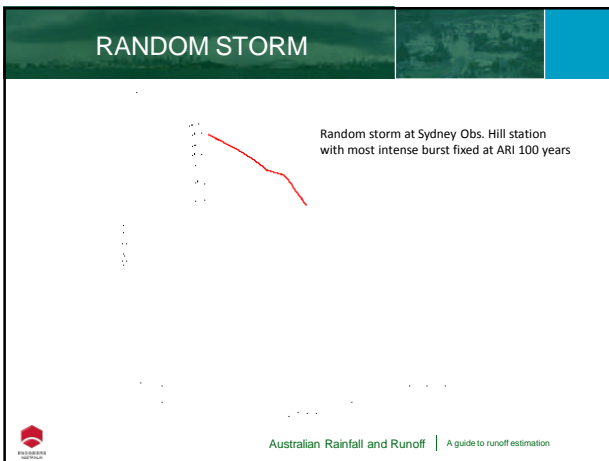


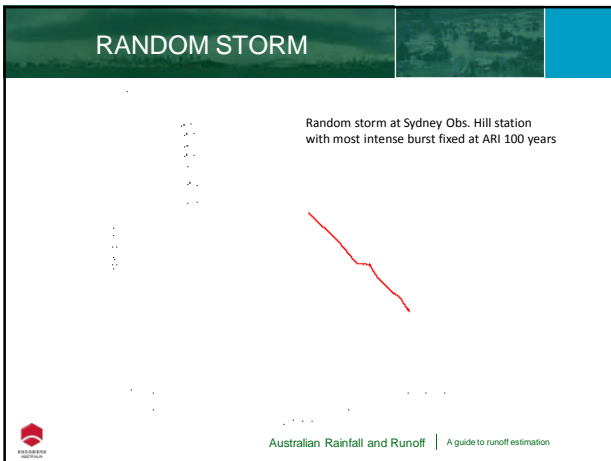


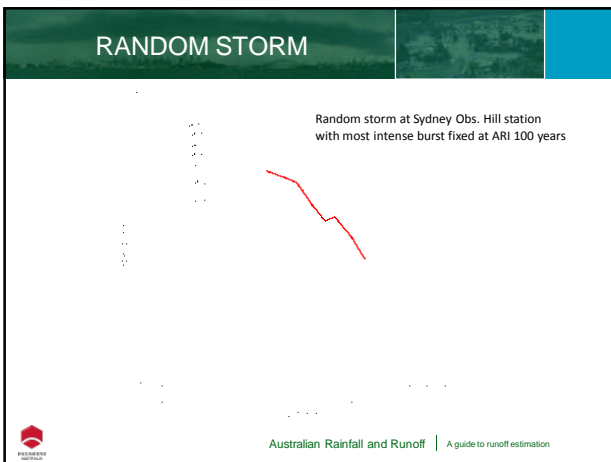


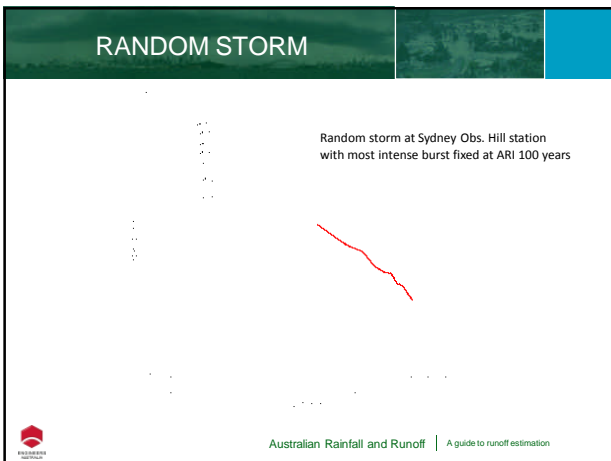


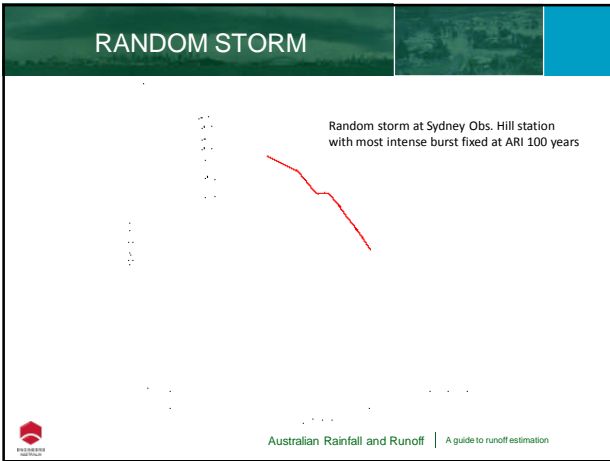


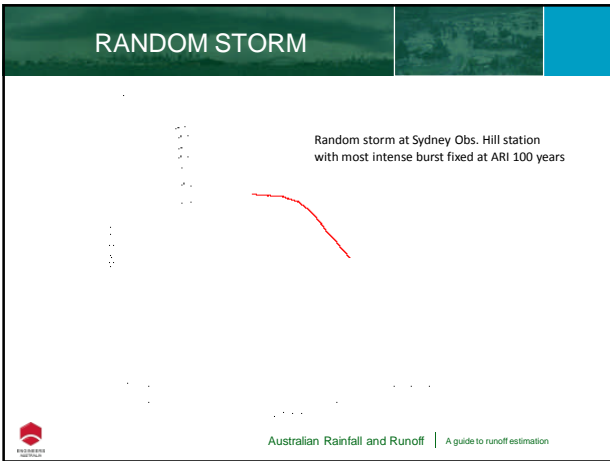


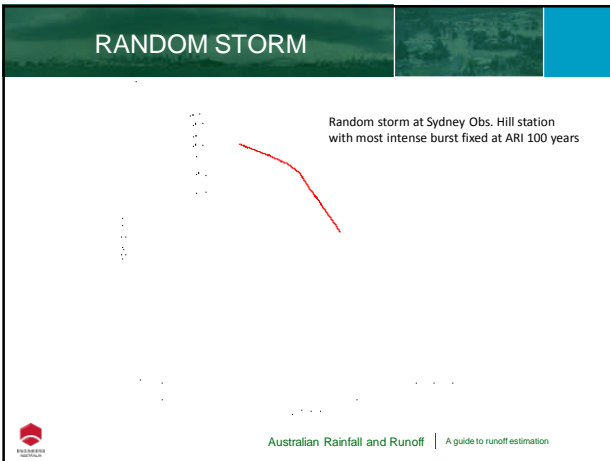


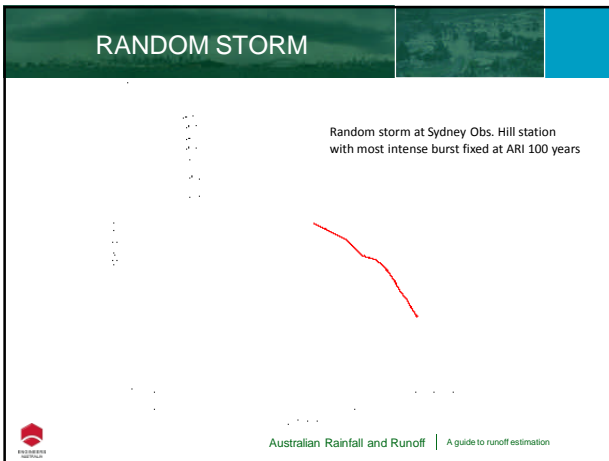


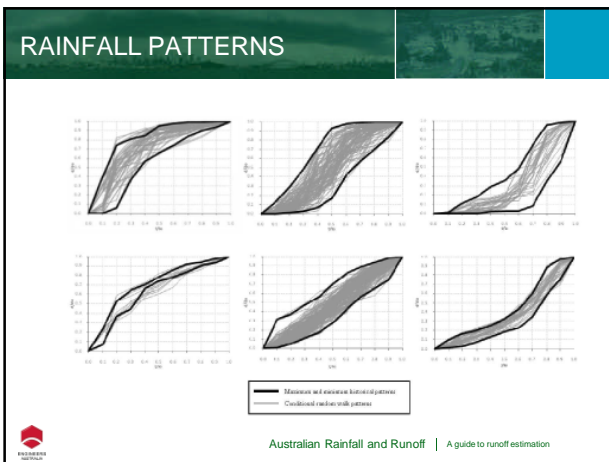












ARR RESEARCH PROJECT 3

Future activities

- Specialised workshop completed last week.
- Discussion paper to be prepared on basis of that workshop.


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ARR RESEARCH PROJECT 4

Continuous rainfall sequences at a point

The outcomes from this project will be

- Validation of the use of continuous rainfall sequences for estimation of flood flows with a desired; and
- Assessment of likely changes in rainfall sequences arising from climate change.




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ARR RESEARCH PROJECT 4

Continuous Rainfall Sequences at a Point

- Started in January 2009
- Techniques considered include
 - Transition probability matrices
 - Non-parametric approaches
 - DRIP style approaches
- Report on Stage 1 delivered and currently being reviewed.




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ARR RESEARCH PROJECT 5

Regional flood methods

The outcomes from this project will be


- Techniques and guidelines for peak flow estimation at ungauged sites across Australia.
- Approach should be independent of climate regime.



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PROJECT TEAM


- Project Team:
 - Dr Ataur Rahman (Project Leader)
 - Mr Khaled Haddad (Project Researcher)
 - Mr Erwin Weinmann
 - Professor George Kuczera
 - A/Prof Ashish Sharma
- State Representatives:
 - Victoria: Mr Erwin Weinmann
 - NSW and ACT: Dr Ataur Rahman
 - Qld: Dr William Weeks
 - WA: Mr Jerome Goh
 - SA: Dr David Kemp
 - Tasmania: Dr Fiona Ling
 - NT: Mr Lakshman Rajaratnam



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POTENTIAL METHODS


- Quantile Regression Technique (QRT) using
 - using ordinary least squares (OLS); and
 - generalised least squares (GLS)]
- Probabilistic Rational Method (PRM)
- Parameter Regression Technique (PRT)
 - predict parameters of a probability distribution using catchment characteristics.



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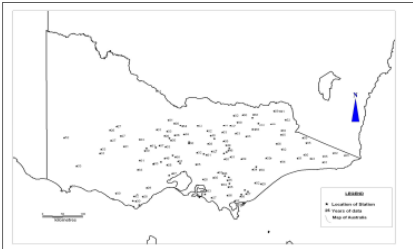
PROJECT 5 - Victoria

- 131 catchments with at least 25 years of streamflow records.
- PRM, OLS and GLS methods applied.



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PROJECT 5 – Victoria



Locations of the study 133 catchments

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The slide features a title bar with 'PROJECT 5 – Victoria' in white text on a dark green background. Below the title is a map of the state of Victoria, Australia, with 133 small black dots representing the study catchments. A legend in the bottom right corner of the map identifies the symbols: a black dot for 'Location of Station', a black square for 'Flow of data', and a black circle for 'Map of catchment'. Below the map, the text 'Locations of the study 133 catchments' is centered. At the bottom left is the Australian Rainfall and Runoff logo, and at the bottom center is the text 'Australian Rainfall and Runoff | A guide to runoff estimation'.


PROJECT 5 - NSW

- 96 stations with a minimum 25 years of streamflow data
- PRM, OLS and GLS methods applied.

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The slide features a title bar with 'PROJECT 5 - NSW' in white text on a dark green background. Below the title, there are two bullet points in green text: '96 stations with a minimum 25 years of streamflow data' and 'PRM, OLS and GLS methods applied.'. At the bottom left is the Australian Rainfall and Runoff logo, and at the bottom center is the text 'Australian Rainfall and Runoff | A guide to runoff estimation'.

PROJECT 5 - NSW




Locations of the 96 stations

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The slide features a title bar with 'PROJECT 5 - NSW' in white text on a dark green background. Below the title is a map of New South Wales, Australia, with 96 small black dots representing the study stations. The text 'NEW SOUTH WALES' is printed on the map. Below the map, the text 'Locations of the 96 stations' is centered. At the bottom left is the Australian Rainfall and Runoff logo, and at the bottom center is the text 'Australian Rainfall and Runoff | A guide to runoff estimation'.

PROJECT 5 - Tasmania


- 44 stations selected from Tasmania.
- Streamflow data have been prepared.
- At-site flood frequency analysis completed.
- Catchment data abstraction are in progress.
- Some additional stations will be provided by BOM and DPIW.



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PROJECT 5 - South Australia


- SA team (Guna Hewa, Trevor Daniell and David Kemp) have selected 35 catchments.
- Streamflow data have been prepared.
- At-site FFA has been completed (GEV-LH moments method).
- Catchment data set nearly ready.



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PROJECT 5 - Queensland

- Development of a new procedure for Queensland.
- Based on QRT.
- Similar procedure as other states.
- Uses all recorded streamflow data for the state.



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PROJECT 5 - Queensland

- All streamgauges with more than 10 years of data.
- “Good” data.
- Less than 1,000 km².
- 289 stations.
- Database prepared.




Figure 1 - Stations included in study

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PROJECT 5 - NT

- Methods proposed by Bill Weeks and Lakshman Rajaratnam (2005).
- Based on Weeks et al. (2002). “Alice Springs – Darwin Railway: Regional Flood frequency Assessment”. Hydrology Symp., Melbourne.
- This may be considered as the recommended technique for NT.

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RATING CURVE ACCURACY

- *Extrapolation of rating curves* beyond largest measured flow can introduce *significant errors*
- Rating curve accuracy is expressed by

$$\text{Rating Ratio (RR)} = \frac{Q_E}{Q_M}$$

- Q_E = annual maximum flood value *estimated* from rating curve
- Q_M = maximum *measured* flow used to construct rating curve
- $RR \approx 1 \Rightarrow$ no rating curve extrapolation error

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RATING RATIO

- Typical example

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RATING RATIO

- A rating ratio of 20 appears reasonable.
- Any station with RR > 20 excluded.

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ARR RESEARCH PROJECT 5

Regional Flood Estimation Methods

- Multi-year project with the aim of providing a nationally consistent and coherent methodology for estimating flood quantiles in rural catchments.
- All states participating.
- Report from Stage 1 received and currently being reviewed.


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ARR RESEARCH PROJECT 6

Loss models for catchment simulation

Outcomes from this project will be

- Statistical loss model parameters to ensure AEP neutrality; and
- Deterministic (?) loss model parameters for situations where AEP neutrality is not a requirement.

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ARR RESEARCH PROJECT 6

Current status is

- Discussion paper being prepared.
- Project workshop to held shortly.


Project scheduled to start during Stage 2 of the ARR Research Projects.

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ARR RESEARCH PROJECT 7

Baseflow for Catchment Simulation


- Aim is to provide guidance on likely baseflow conditions when the flood flow is not the majority of the flow (e.g. some environmental flood flow problems).
- Multi-year project.
- Report on Stage 1 expected shortly

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ARR RESEARCH PROJECT 8

Use of continuous simulation for design flow determination

The outcome from this project will be guidance on when and how continuous simulation can be used for estimation of flows with a given AEP.




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ARR RESEARCH PROJECT 8

Current status is

- Discussion paper (combined with Projects 12 and 20) is being prepared.
- Project workshop to be held shortly.

Project scheduled to commence in Stage 2 of ARR Research Projects.



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ARR RESEARCH PROJECT 9

Urban Drainage System Hydraulics

– Project aims are

- Collating information on structures within urban drainage systems
- Both quantity and quality devices will be considered
- Provision of guidance on where more information is needed.

Stage 1 report received and currently being reviewed.



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ARR RESEARCH PROJECT 10

Appropriate safety criteria for people
Arising from this project will be presentation of guidelines about personnel safety in flood situations.



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ARR RESEARCH PROJECT 10

Current status is
– Project under progress since late 2008.
– Has confirmed reliability of UNSW data with other data collected from around the world – significant implications for assessing safety of people in floods.


Draft Report expected shortly.



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ARR RESEARCH PROJECT 11

Blockage of hydraulic structures
The outcome here will be guidance on the blockage of structures during flood events.




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ARR RESEARCH PROJECT 11

Current status is

- First stage was collating available data for both urban and rural catchments.
- Number of workshops have been held on this project.

Report on Stage 1 received and now being reviewed.



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ARR RESEARCH PROJECT 11

- **Bill Weeks, Queensland DMR.**
- Monique Retallick, WMAwater.
- James Ball, UTS.
- **Ted Rigby, Rienco.**
- Pas Silveri, Wollongong City Council.
- **Anthony Barthelmess, Cardno Forbes Rigby.**
- Paul Doherty, Melbourne Water.
- Bill Lipp, SA Dept of Transport, Environment and Infrastructure.
- **Grant Witheridge, Catchments & Creeks.**
- Alastair Peddie, Newcastle City Council.
- George Kuczera, University of Newcastle.
- Geoff O'Loughlin, Anstad Pty Ltd.
- Bob Adamson, Brisbane City Council.
- Bob Keller, Monash University.

Highlighted are significant contributors.




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ARR RESEARCH PROJECT 11


- Blockage causes a range of problems in drainage systems, as well as serious damage at times.
- It is poorly documented in publications such as ARR.
- This project is aimed at improving guidelines.



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Debris in Wollongong - 1998



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Debris on Bridges in Qld



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110


Debris in Newcastle 2007



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MAJOR ISSUES

- Causes of the blockage.
 - This includes the type of material that may cause the blockage, and the amount of material transported and the risk of collection by the drainage infrastructure.
- Impacts of blockage.
 - Blockage can cause damage to infrastructure and risk to people as well as causing it to operate below capacity.
 - Details of how this happens should be considered.
 - Approaches to minimising the risk of blockage need to be considered.

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MAJOR ISSUES

- Assessment methods.
 - There are some rules of thumb on how blockage can be assessed, which may be a percentage blockage.
 - The mechanism of the blockage could be reviewed and the impacts of different mechanisms need to be developed.
 - The assessment of risk of blockage and the consequences would be covered here.
- Analysis methods.
 - The hydraulic analysis of drainage systems needs to incorporate appropriate blockage mechanisms and amounts of debris.
 - Suitable parameters and techniques need to be developed.

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MAJOR ISSUES

- Maintenance approaches.
 - Minimising the amount of blockage would be the best approach, but if this is impossible, suitable maintenance measures need to be considered.

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Procedure – Stage 1 (2008/09)


- Workshop of selected experts contributed.
- Report on preliminary assessment of issues will be published as Stage 1 report.
- Paper submitted for Hydrology & Water Resources Symposium in November.
- Feedback and additional contributions sought from stakeholders.



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Procedure - Stage 2 (2009/10)

- Following input on Stage 1 report, further work will continue as Stage 2.
- Stage 2 report will include.
 - Refinement of Stage 1 findings.
 - Recommendations of procedures and parameters for incorporation of blockage into hydraulic designs.




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ARR RESEARCH PROJECT 12

Selection of an approach

The aim of this project is to test methods for selection between alternative flood flow estimation techniques.




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ARR RESEARCH PROJECT 12

Current status is

- Discussion paper (combined with Projects 8 and 20) is being prepared.
- Project workshop to be held shortly.

Project scheduled to commence in Stage 2 of ARR Research Projects.




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ARR RESEARCH PROJECT 13

Rational Method developments

The expected outcome is the collection of information pertinent to the Rational Method and its application in Australia.




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ARR RESEARCH PROJECT 13

Rational Method Developments

- Aim is to provide guidance on use of the Rational Method including
 - Recent studies (e.g. WP Research in Canberra)
 - Inconsistencies in recommended approaches
 - Uncertainty in predicted flows
- Rational Method is well used but seriously questioned by many, predictions rarely confirmed by reference to gauged data.




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ARR RESEARCH PROJECT 13

Recent progress

- Literature review complete and report prepared;
- Analysis of reliability commenced; and
- Catchment data being mined but not successfully yet due to lack of suitable gauged catchments.




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ARR RESEARCH PROJECT 14

Large to extreme floods in urban areas

Development of accepted approaches for estimation of extreme and large flood events in urban areas is the focus here.

Not due to start till Stage 3 (2010-2011).




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ARR RESEARCH PROJECT 15

Two-dimensional simulation in urban areas

The aim here is to develop guidelines for the use of these two-dimensional modelling systems in urban environments.



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ARR RESEARCH PROJECT 15

Current status is

- Project commenced in September with a workshop at Hydraulics Conference in Darwin.
- Used a Wiki for general input by industry and researchers into a report framework.
- Meetings have been held regularly and this project has developed significantly.


Stage 1 report expected shortly.



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ARR RESEARCH PROJECT 15

1. Introduction
2. 2D Conceptualisation
3. Overview of Modelling approaches
4. Planning the Modelling Process
5. Data Requirements
6. Model Schematising / Implementation / Assembly
7. Calibration Process
8. Interpretation of Results
9. 1D/2D models
10. Direct Rainfall
11. Current Issues with 2D Modelling
 - Supercritical flow
 - Adaptive timesteps/run times
 - Wetting/Drying
 - Valid Parameter ranges/envelopes
 - Eddy Viscosity
 - Very shallow and very deep flow
 - Numerical precision and accuracy issues
 - Sub grid features
 - Structures
 - Buildings and fences
 - DTM Considerations
12. Recommendations and Conclusions
13. Glossary
14. Models



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ARR RESEARCH PROJECT 15

Project has demonstrated the desire of the profession for provision of quality guidance

- Major software suppliers have been involved;
- Major users have been involved; and
- Academics and researchers have been involved.



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ARR RESEARCH PROJECT 15

Current status is

- Draft report circulated to participants, expected to be submitted shortly as a formal draft for independent review.
- Draft report without figures is approximately 280 pages.




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ARR RESEARCH PROJECT 16

Storm patterns for use in design events

Arising from this project will be

- Information regarding the spatial extent of individual storm bursts and their associated probabilities;
- Information about the correlation structure of individual storm bursts within the one catchment area and the associated probabilities;
- Evaluation of the influence of the spatio-temporal rainfall model on a drainage system;
- An assessment of the uncertainties associated with this approach; and
- A qualitative assessment of likely changes arising from climate change.




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ARR RESEARCH PROJECT 16

Current status:

- Discussion paper prepared;
- Workshop held last week;
- Future developments
 - Report on Workshop being written;
 - BoM radar downscaling approach to be investigated; and
 - Spatial-temporal model of rainfall based on clustered point processes to be considered also.

Due to start in Stage 2.



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ARR RESEARCH PROJECT 17

Channel loss models

This project will result in the development of models and parameters for estimation of channel losses.




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ARR RESEARCH PROJECT 17

Current status is

- Discussion paper is being prepared in conjunction with Project 6.
- Workshop to be held shortly.

Due to start in Stage 2.




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ARR RESEARCH PROJECT 18

Interaction of coastal processes and severe weather events

Guidelines for assessment of the interaction (joint probability) between storms and ocean levels.




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PROJECT 18

Current status is

- Discussion paper is being prepared. Draft received and review comments provided, Final version expected shortly.
- Workshop is being developed.
- Discussions between Australian and International researchers being held akso.




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ARR RESEARCH PROJECT 19

Selection of climate change boundary conditions

The outcome of this project will be development of suitable advice on selecting appropriate planning horizons and climate change projections.




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ARR RESEARCH PROJECT 20

Risk assessment and design life

Outcomes from this project will be an approach suitable for assessing the interaction between the design life of a structure and its vulnerability to flood flows.




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ARR RESEARCH PROJECT 20

Current status of the project is

- Discussion paper is being prepared in conjunction with projects 8 and 12.
- Workshop to be held shortly.



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ARR RESEARCH PROJECT 21

IT Delivery and Communication strategies

The outcomes from this project will be the dissemination of rainfall and hydrologic data and its analysis through an evaluated communication strategy employing printed reference material, web delivery, dedicated software tools, and public education modules.



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ADMINISTRATION

- Getting involved
 - Mail lists
 - Regional focus groups
 - Opportunities for input
- Updates
 - Draft books on www.arr.org.au
 - Information on www.arr.org.au




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BOOK LAYOUT

Current and proposed layouts are


- 1987 Version
 - 14 Chapters in 1 book.
- 1997 version
 - 14 Chapters split over 8 books.
- 4th Edition – 2012
 - 39 Chapters distributed over 9 books



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BOOK LAYOUT


Book I - SCOPE AND PHILOSOPHY <ol style="list-style-type: none">1. INTRODUCTION2. RANGE OF APPLICATIONS3. RISK BASED DESIGN4. CLIMATE CHANGE	Book II - APPROACHES TO RUNOFF ESTIMATION <ol style="list-style-type: none">1. INTRODUCTION2. HYDROLOGIC DATA3. RANGE OF TECHNIQUES4. SELECTION OF AN APPROACH
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BOOK LAYOUT


Book III - RAINFALL ESTIMATION <ol style="list-style-type: none">1. INTRODUCTION2. SYNTHETIC RAINFALL BURSTS3. SYNTHETIC STORMS4. CONTINUOUS RAINFALL SEQUENCES	Book IV - PEAK FLOW ESTIMATION <ol style="list-style-type: none">1. INTRODUCTION2. AT-SITE FLOOD FLOW FREQUENCY ANALYSIS3. REGIONAL METHODS FOR FLOOD FLOW ESTIMATION
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BOOK LAYOUT

Book V - HYDROGRAPH ESTIMATION <ol style="list-style-type: none">1. INTRODUCTION2. EVENT BASED MODELS3. CONTINUOUS RUNOFF ESTIMATION4. LOSS MODELS5. BASEFLOW ESTIMATION6. SURFACE RUNOFF ESTIMATION	Book VI - FLOW HYDRAULICS <ol style="list-style-type: none">1. INTRODUCTION2. BASIC ASPECTS OF OPEN CHANNEL HYDRAULICS3. HYDRAULIC STRUCTURES4. UNSTEADY FLOW AND NUMERICAL MODELS
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BOOK LAYOUT

BOOK VII – APPLICATION OF CATCHMENT MODELLING SYSTEMS <ol style="list-style-type: none">1. INTRODUCTION2. CATCHMENT MODELLING PRINCIPLES3. SELECTION, CALIBRATION, AND VALIDATION OF PARAMETERS4. RISK AND UNCERTAINTY DETERMINATION	Book VIII – LARGE TO EXTREME FLOOD ESTIMATION <ol style="list-style-type: none">1. INTRODUCTION2. ?? <p>This book is the most recently modified and hence less consideration has been given to the chapter layout.</p>
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BOOK LAYOUT

Book IX – RUNOFF IN URBAN AREAS <ol style="list-style-type: none">1. INTRODUCTION2. ANTHROPOGENIC INFLUENCES3. URBAN DRAINAGE CONCEPTS4. DRAINAGE SYSTEM HYDROLOGY<ol style="list-style-type: none">1. RATIONAL METHOD5. DRAINAGE SYSTEM HYDRAULICS6. RUNOFF DETENTION AND RETENTION7. SAFETY CRITERIA8. URBAN DRAINAGE MODELLING	
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