




ARR Revision Project 1:
Development of
Intensity-Frequency-
Duration Information Across
Australia




Supported By




Australian Government



Work carried out by

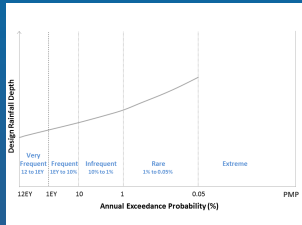



Australian Government
Bureau of Meteorology



Design rainfalls

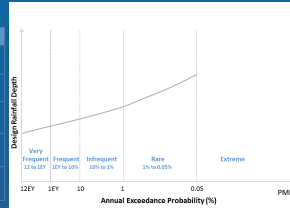
Probability	Occurrence
> 1 Exceedance per year (EY)	Very frequent
1 EY to 10% AEP	Frequent
10% to 1% AEP	Infrequent
1% to 0.05% AEP	Rare
Extreme	Extreme





Design rainfalls

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5 Frequent Design Rainfall

20/10/15

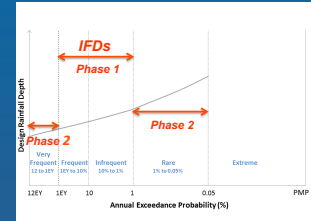


ARRS
Australian Rainfall & Runoff



New Design Rainfall Project

- Phase 1
 - Frequent & infrequent (IFDs)
 - Released 1 July 2013
- Phase 2
 - Very frequent
 - Rare
 - To be released November 2015
- Bureau contribution
 - ~ 50 person years
 - ~\$6 million



5 Frequent Design Rainfall

20/10/15

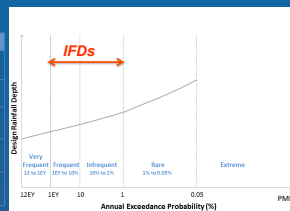


ARRS
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IFDs

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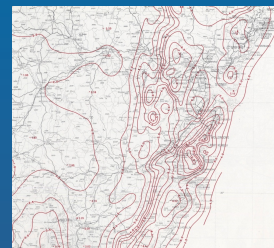


ARRS
Australian Rainfall & Runoff



Previous IFDs

- 1987 Australian Rainfall & Runoff
- Developed nearly 30 years ago
- Bureau's daily read & pluviograph stations
- Techniques appropriate at the time
- Focus on structures in large rural catchments
 - Durations less than 5 minutes not provided
- Climate change not considered



5 Frequent Design Rainfall

20/10/15

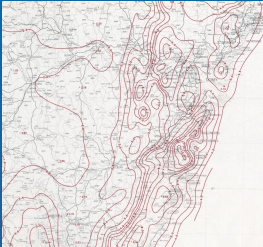



ARRS
Australian Rainfall & Runoff




Need for Revision


- Availability of longer rainfall records
 - Nearly 30 years more data
- Expanded datasets
 - Incorporating data from other organisations
- New statistical & gridding techniques
- Changed user requirements
 - Focus on structures in small urban catchments
 - Need durations as short as 1 minute




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Australian Rainfall & Runoff




INFRASTRUCTURE
AUSTRALIA


Greatly expanded database

Data	New IFDs	ARR87 IFDs
Number of rainfall stations	Daily-read: 8074 Continuous: 2280	Daily-read: 7500 Continuous: 600
Period of record	Up to December 2012	Up to ~1983
Length of record used in analyses	Daily-read: > 30 years Continuous: > 8 years	Daily-read: > 30 years Continuous: > 6 years
Source of data	Organisations collecting rainfall data across Australia	Bureau of Meteorology (primarily)
Quality controlling	Automated and manual	Manual


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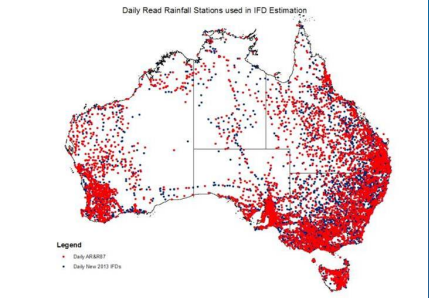
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Australian Rainfall & Runoff



INFRASTRUCTURE
AUSTRALIA


Greatly expanded database


Daily Read Rainfall Stations used in IFD Estimation




Legend

- Daily Read 2012
- Daily Read 1983


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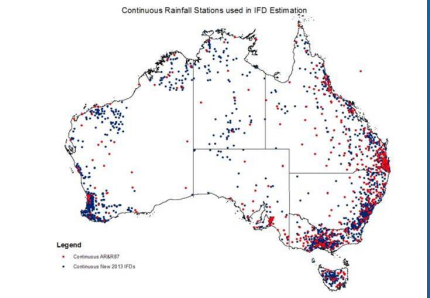
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INFRASTRUCTURE
AUSTRALIA


Greatly expanded database


Continuous Rainfall Stations used in IFD Estimation




Legend

- Continuous 2012
- Continuous 1983


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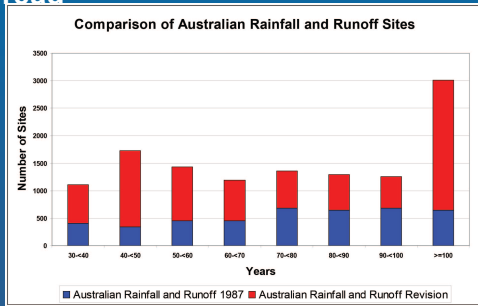


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Australian Rainfall & Runoff



INFRASTRUCTURE
AUSTRALIA

Longer period of record – daily read



1.5 Frequent Design Rainfall

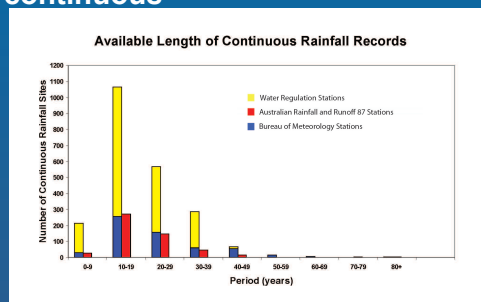
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Longer period of record - continuous



1.5 Frequent Design Rainfall

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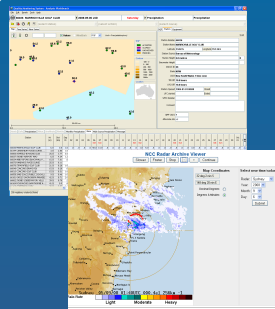
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Quality controlling of data

- All data quality controlled
- Enormous amount of data needing to be quality controlled
 - > 20 000 daily read stations
 - > 4 000 continuous rainfall stations
- Necessitated automating QCing as much as possible
- However still required considerable manual QCing using Bureau's Quality Monitoring System (QMS)
 - ~ 3 years QCing data



1.5 Frequent Design Rainfall

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'State of the science methods'

Step	New IFDs	ARR87 IFDs
Extreme value series	Annual Maximum Series	Annual Maximum Series
Frequency analysis	Generalised Extreme Value distribution fitted using L-moments	Log-Pearson Type III distribution fitted using method of moments
Extension of sub-daily rainfall statistics to daily-read stations	Bayesian Generalised Least Squares Regression	Principal Component Analysis
Gridding	Objective; automated gridding procedure using ANUSPLIN	Maps hand-drawn

1.5 Frequent Design Rainfall

20/10/15

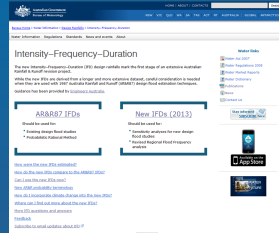
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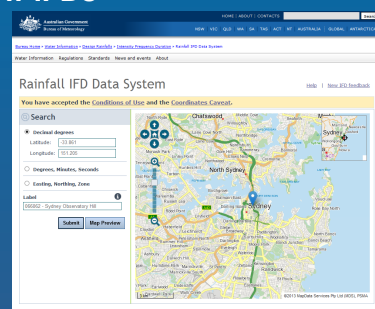


New IFDs

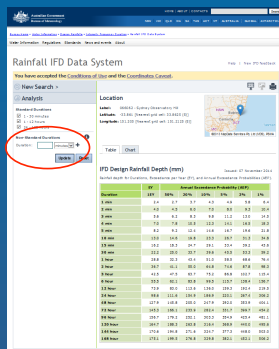
- Released 1 July 2013
- Standard durations of:
 - 1, 2, 3, 4, 5, 10, 15, 30 minutes
 - 1, 2, 3, 6, 12 hours
 - 1, 2, 3, 4, 5, 6, 7 days
- Standard probabilities of:
 - 1EY (1 exceedance per year)
 - 50%, 20%, 10%, 5%, 2%, 1% AEP
- Available via web – includes lots of information



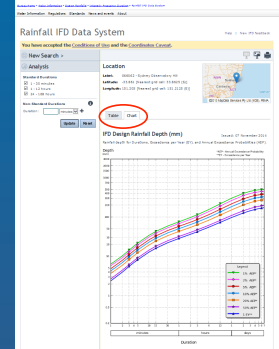
New IFDs

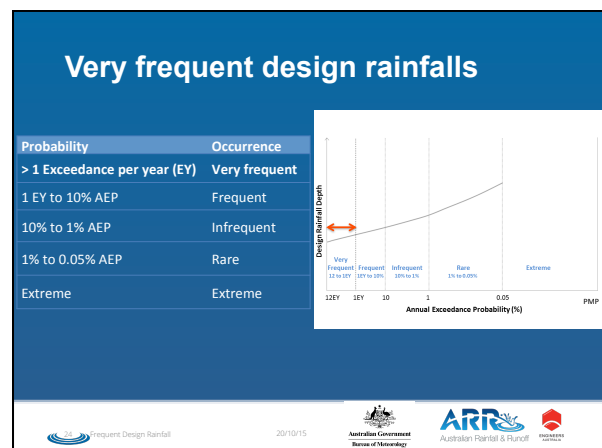
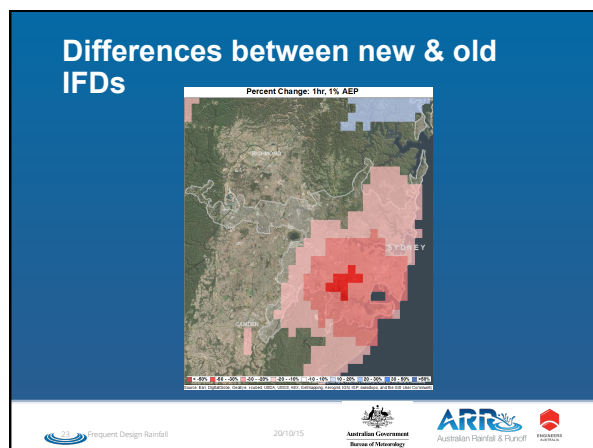
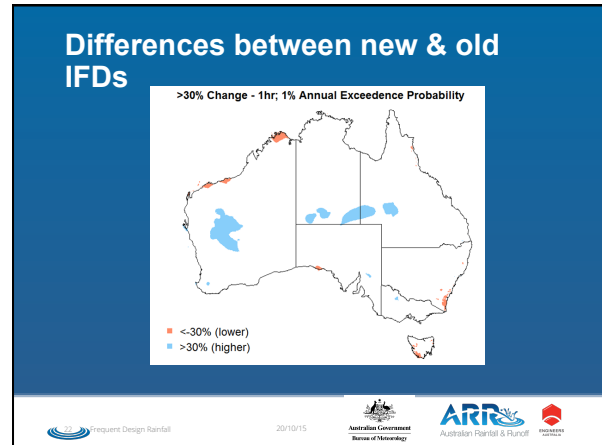
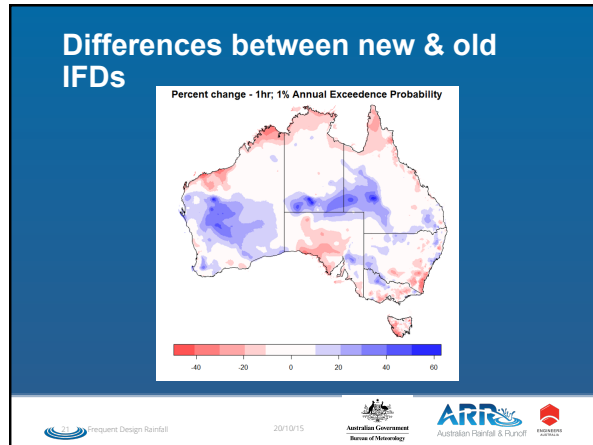


New IFDs



New IFDs





Very frequent design rainfalls

- Probabilities > 1EY
- Estimates not previously provided
- Limited information available on very frequent design rainfalls

EY	AEP (%)	ARI (years)	ARI (months)
12	99.99	0.08	1 month
6	99.75	0.17	2 month
4	98.17	0.25	3 month
3	95.02	0.33	4 month
2	86.47	0.50	6 month
1	63.21	1.00	12 month

Very frequent design rainfalls

STATION NO. 55054 TANKNORTH AIRPORT	
MINIMUM MONTHS 10	MINIMUM SEPARATION 1440 MINUTES 100% 0
PERIOD FROM 1958 TO 1992	
NUMBER OF COMPLETE YEARS 33	
DEPTHS IN MILLIMETRES FROM PARTIAL SERIES - DATA SMOOTHED	
DURATION	1 M 2 M 3 M 4 M 5 M 6 M 12 M 18 M 30 M 60 M 120 M 180 M 360 M 720 M 1440 M 2880 M 4320 M
ARI	
0.25 YEARS	0.8 1.6 2.3 2.9 3.5 4.1 6.3 7.6 9.1 11.7 15.1 17.7 22.3 27.0 32.0 37.2 40.0
0.50 YEARS	1.2 2.3 3.2 4.0 4.8 5.4 8.4 10.5 12.9 17.0 21.9 25.9 29.6 36.2 44.0 51.1 56.7
1.00 YEARS	1.6 2.9 4.1 5.1 6.0 6.7 10.5 13.4 17.4 22.3 26.9 30.2 37.0 45.4 56.0 65.0 69.4
2.00 YEARS	2.0 3.6 5.0 6.2 7.3 8.1 12.6 16.3 21.5 27.7 32.8 36.5 44.4 54.6 68.0 78.9 84.2
5.00 YEARS	2.5 4.5 6.2 7.4 8.9 9.9 15.4 20.1 27.0 34.7 40.6 46.7 56.2 68.8 83.8 97.3 103.7
10.00 YEARS	2.9 5.2 7.2 8.7 10.2 11.1 17.5 23.0 31.1 40.0 46.5 53.0 63.6 76.0 95.8 111.2 118.4

Very frequent design rainfalls

Source	WSUD Guideline	Method
Hastings Council Stormwater Management	Design Storm equivalent to a 3 month ARI storm event	40% of 1 year ARI storm event
Parramatta City Council Stormwater Asset Plan	3 month ARI storm event	$0.5 \times Q_{1\text{year}}$ (flow)
South Australia Government	3 month design flows	Logarithmic extrapolation of design flows from AR&R67
NSW State Government Stormwater Source Control	3 month ARI rainfall event	$25\% \times 1 \text{ year ARI}$ (rainfall)
Gold Coast City Council	Factors applied to 1 in 1 year ARI	3 month ARI = $0.50 \times 1:1 \text{ year ARI}$

Very frequent design rainfalls

- Different methods across Australia
- Affects consistency of design outcomes
 - => derivation of very frequent design rainfalls identified as priority for Phase 2 of New Design Rainfall Project
- Database and method adopted for new IFDs basis of approach
- However, variations required for more frequent probabilities



Very frequent design rainfalls

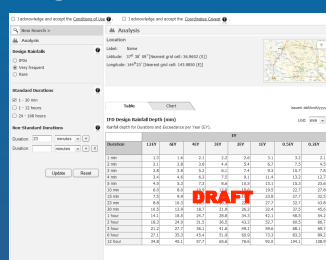
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Number of rainfall stations	Daily-read: 8074 Continuous: 2280	Daily-read: 15 364 Continuous: 2722
Period of record	Up to December 2012	Up to December 2012
Length of record used in analyses	Daily-read: > 30 years Continuous: > 8 years	Daily-read: > 5 years Continuous: > 5 years
Source of data	Organisations collecting rainfall data across Australia	Organisations collecting rainfall data across Australia
Quality controlling	Automated and manual	More!!

Very frequent design rainfalls

Step	New IFDs	Very frequent
Extreme value series	Annual Maximum Series	Partial duration series
Frequency analysis	Generalised Extreme Value distribution fitted using L-moments	Generalised Pareto (GPA) distribution fitted using L-moments
Extension of sub-daily rainfall statistics to daily-read stations	Bayesian Generalised Least Squares Regression	Ratios
Gridding	Objective; automated gridding procedure using ANUSPLIN	Objective; automated gridding procedure using ANUSPLIN

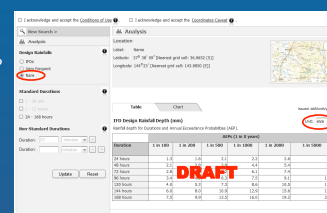
Very frequent design rainfalls

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- Standard durations of:
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 - 1, 2, 3, 6, 12 hours
 - 1, 2, 3, 4, 5, 6, 7 days
- Standard probabilities of:
 - 2, 3, 4, 6 and 12 EY
- Will be available via web



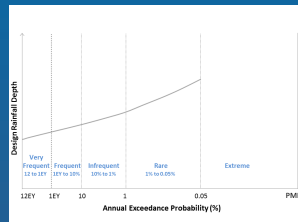
But wait there's more.....

- To be released November 2015
- Rare design rainfalls
 - 1, 2, 3, 4, 5, 6, 7 days
 - 1 in 200; 500; 1000; 2000 AEP
- Areal reduction factors
- Selection of units
 - Depths in mm
 - Intensities in mm/hr



New Design Rainfall Project Outcomes

- Design rainfalls for:
 - Probabilities:
 - 12 EY to 0.05% AEP
 - Durations:
 - 1 minute to 7 days
 - Whole of Australia
 - Derived using consistent database & methods
 - Available from one stop shop



Contacts

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Website: www.bom.gov.au/water/designRainfalls/ifd/index.shtml

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