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Flaws in our understanding and perception of flood risk

Dr Rory Nathan

A/Prof Hydrology & Water Resources
University of Melbourne

Technical Director
Jacobs

Outline

- The 2011 flood event in Brisbane
- Engineering (and media) failings
- Communicating risk
- Estimating flood risk
- Understanding and resilience
- Conclusions

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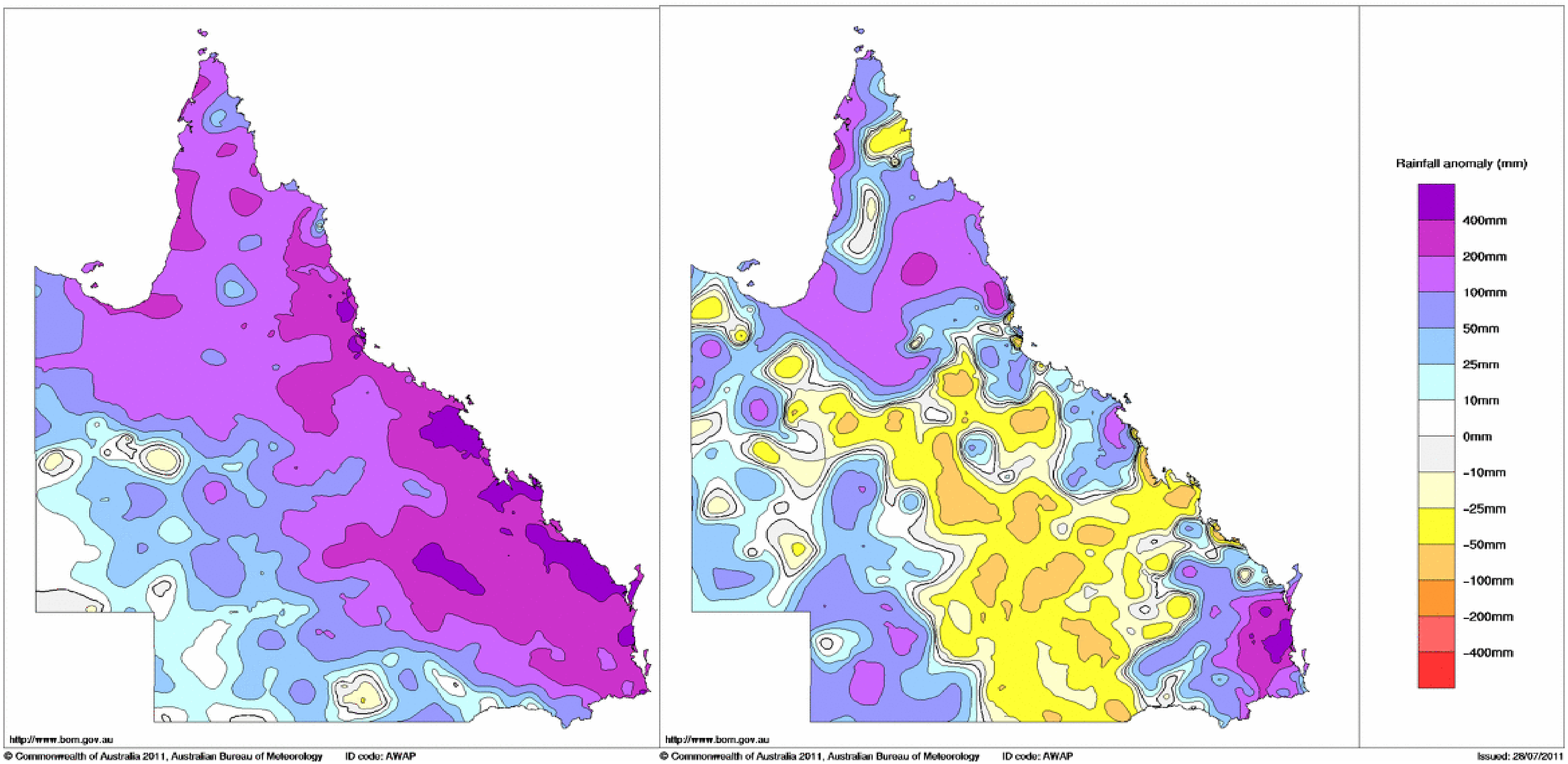
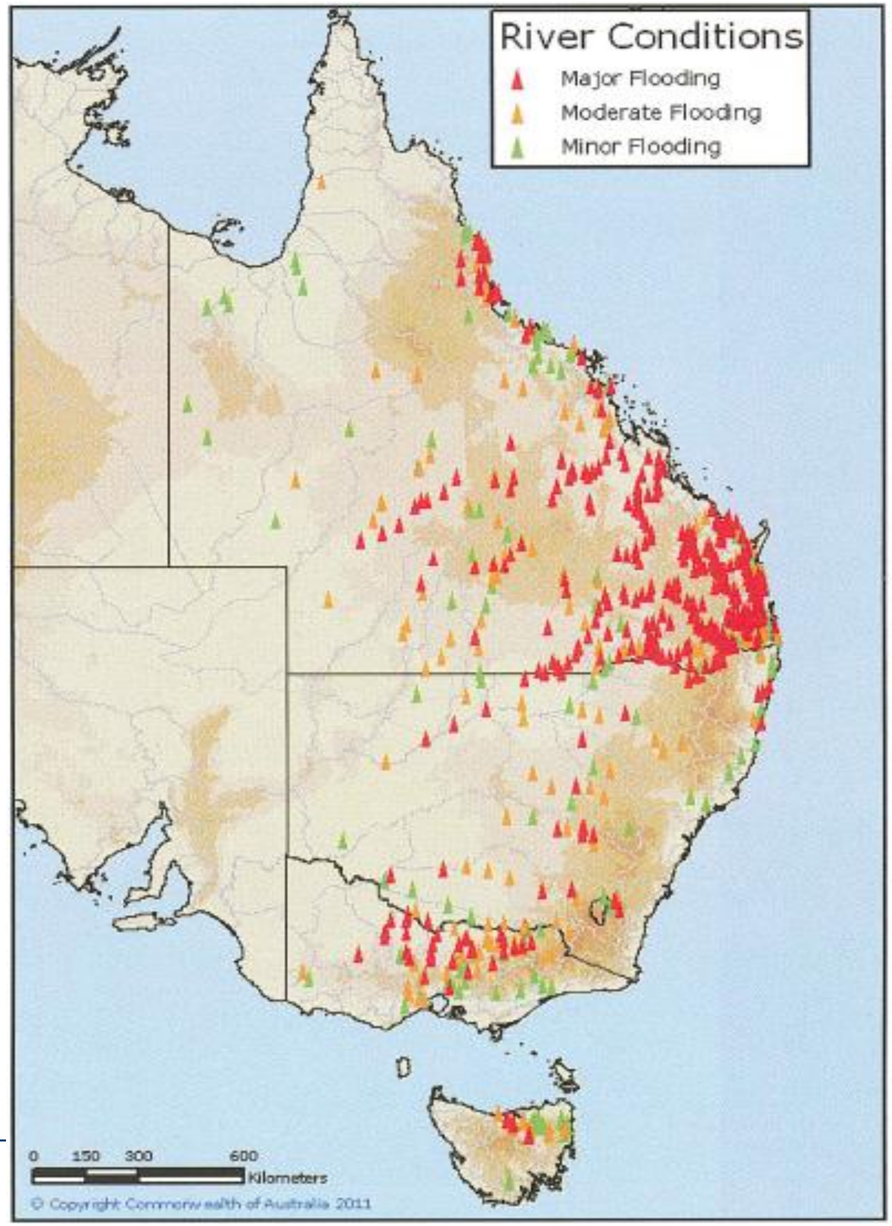
One-Month Rainfall Anomalies



December 2010 January 2011

Flood peaks Nov 2010 – Jan 2011



Bureau of Meteorology


0 min
10/01/2011 03:16 PM


0 min
10/01/2011 03:16 PM


+11 min
10/01/2011 03:27 PM


0 min
10/01/2011 03:16 PM


+11 min
10/01/2011 03:27 PM


+18 min
10/01/2011 03:34 PM


0 min
10/01/2011 03:16 PM
+11 min
10/01/2011 03:27 PM
+18 min
10/01/2011 03:34 PM
+22 min
10/01/2011 03:38 PM

Rocklea (wide view)

Larger Map ▸

http://www.abc.net.au/news/specials/qld-floods/

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Flash Flooding Toowoomba Jan 2011

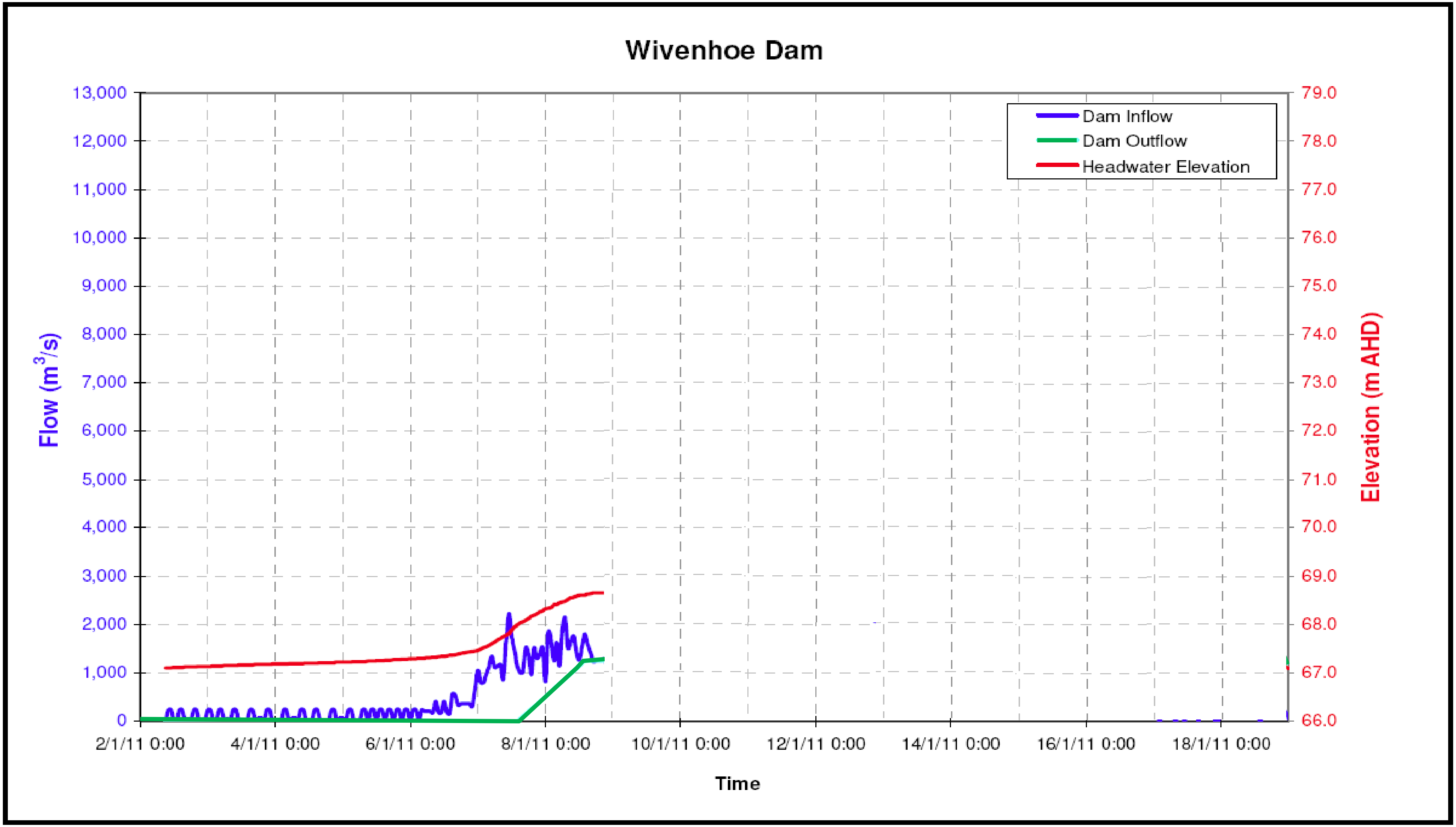
Understanding Floods: Q&A (image from Nicole Hammermeister)

Flash Flooding Toowoomba Jan 2011

Kapernick's bridge

10^{th} Jan 2011

46 mins later



Wivenhoe Dam
Dam Inflow
Dam Outflow
Headwater Elevation
Flow (m3/s)
Elevation (m AHD)
Time
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
66.0
67.0
68.0
69.0
70.0
71.0
72.0
73.0
74.0
75.0
76.0
77.0
78.0
79.0
2/1/11 0:00
4/1/11 0:00
6/1/11 0:00
8/1/11 0:00
10/1/11 0:00
12/1/11 0:00
14/1/11 0:00
16/1/11 0:00
18/1/11 0:00

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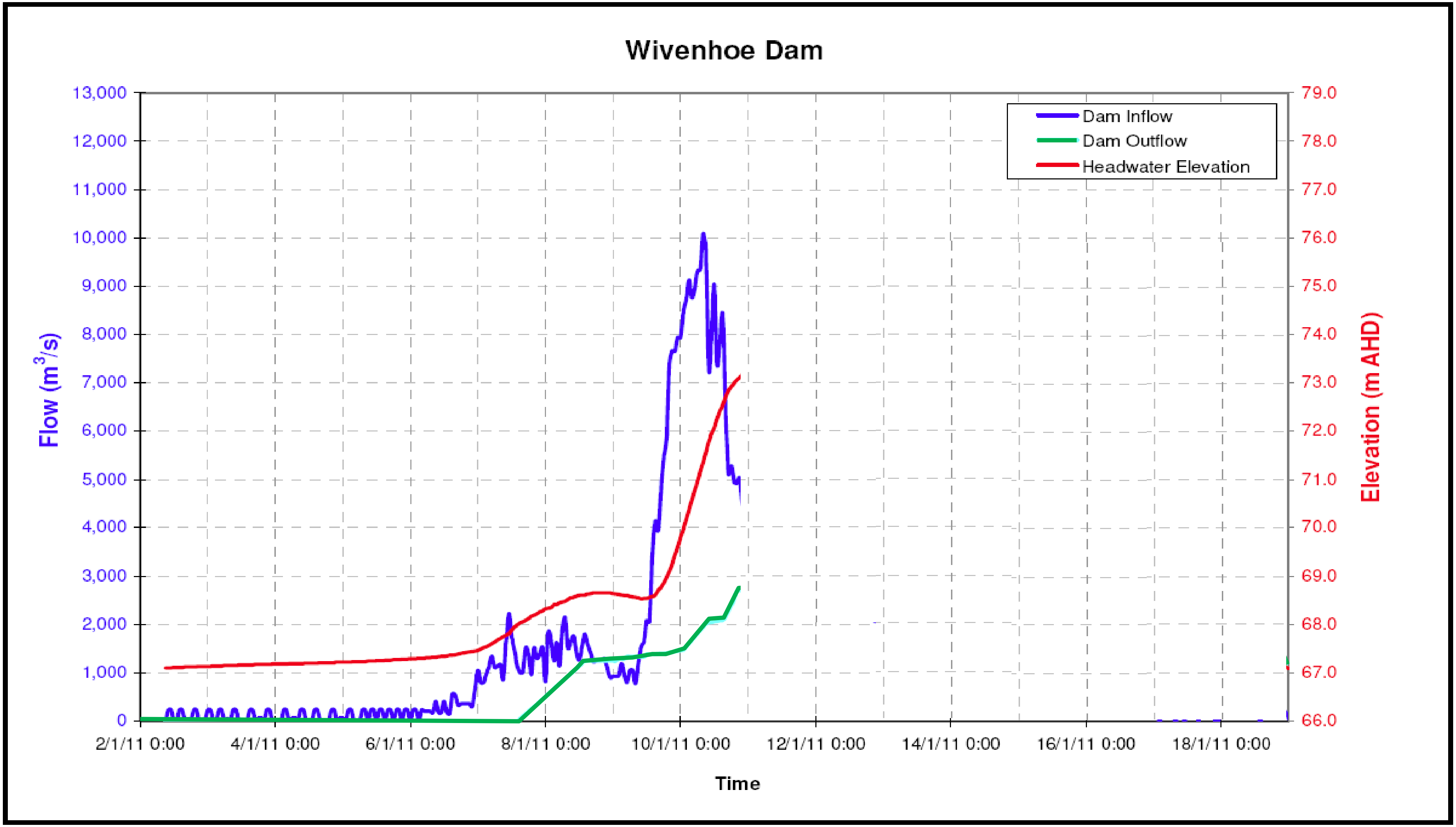

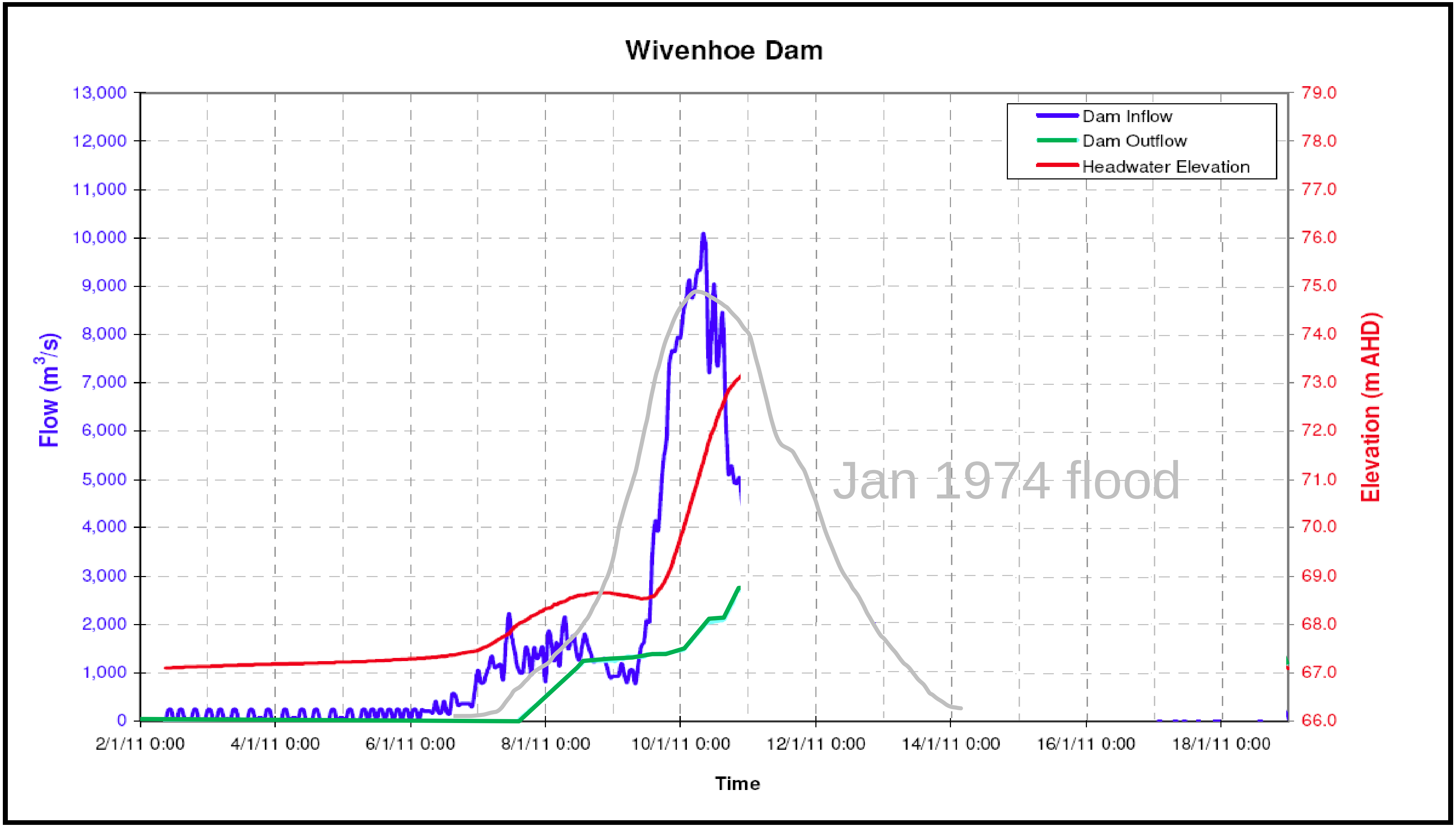

Wivenhoe Dam
Dam Inflow
Dam Outflow
Headwater Elevation
Jan 1974 flood
Flow (m3/s)
Elevation (m AHD)
Time
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
79.0
78.0
77.0
76.0
75.0
74.0
73.0
72.0
71.0
70.0
69.0
68.0
67.0
66.0
2/1/11 0:00
4/1/11 0:00
6/1/11 0:00
8/1/11 0:00
10/1/11 0:00
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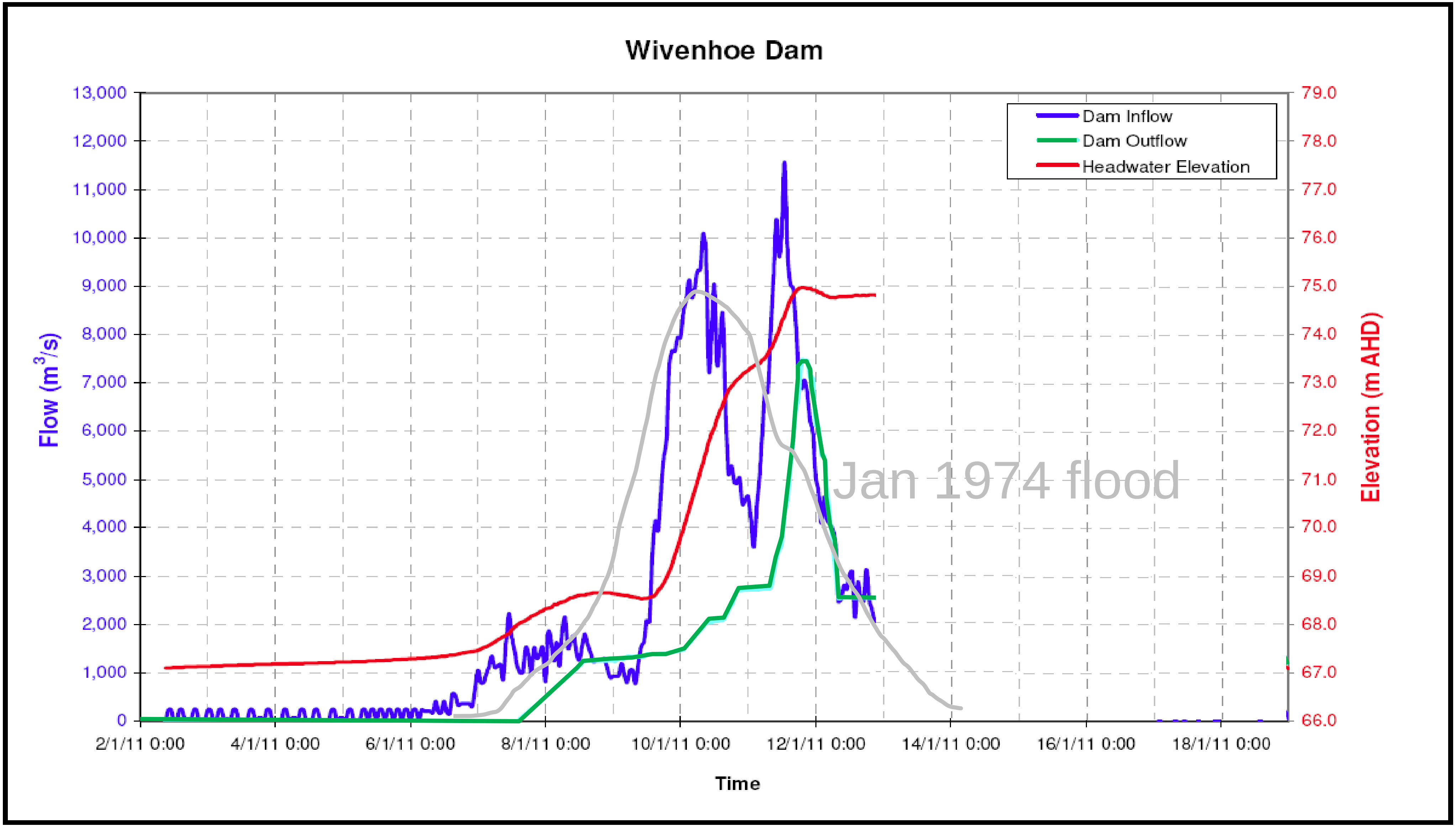

Wivenhoe Dam overflows

Photo: Dean Saffron

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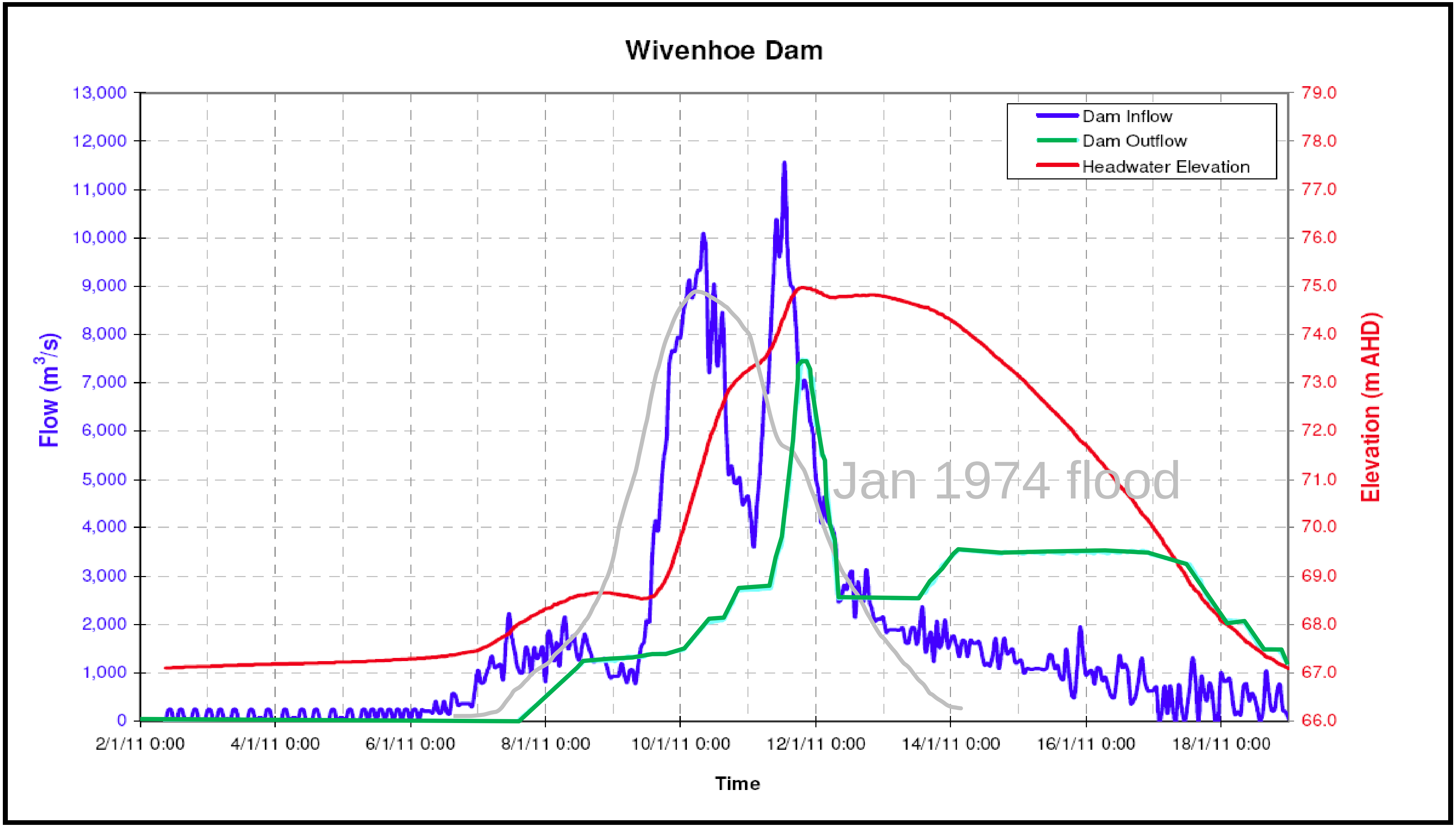

“Dam’s releases blamed for inundation”

“After a week of waiting, Seqwater blames it on the rain”

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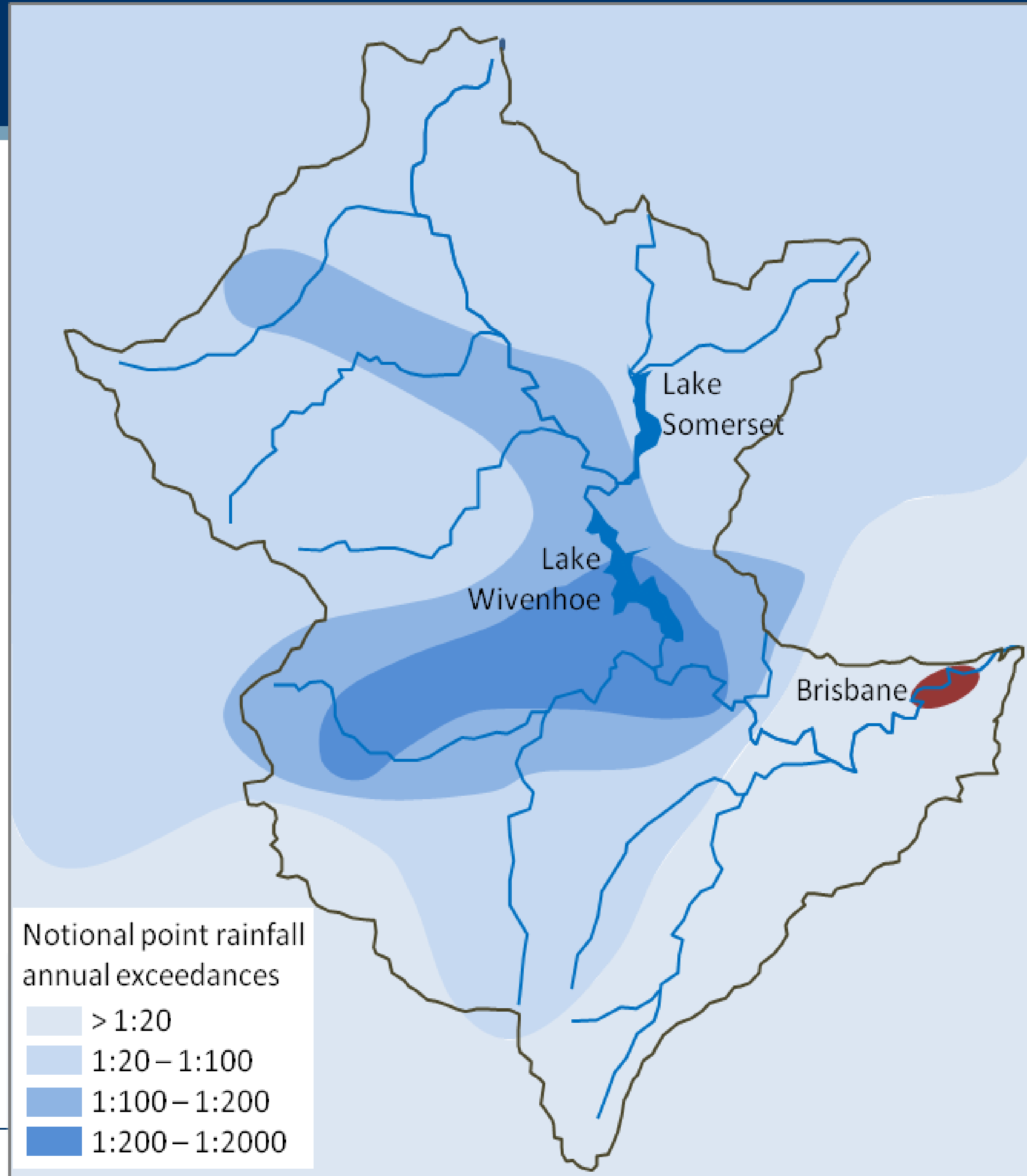
- Big rains cause big floods

Flood volume
= 8 “SydHarbs”



“Dam’s operation model was inaccurate”

“Wivenhoe Dam surge blamed for farm losses”

The Australian, May 20

“Experts say dam added to Queensland flood damage”

Brisbane Courier Mail, March 7th

Engineers' Failings

- Those most informed were conflicted out from speaking publicly
- Those remaining showed a willingness to:
  - speak outside field of expertise
  - offer an opinion based on incomplete knowledge
  - join in the blame game
- Subject matter arrogance over situation-specific knowledge
- Naiveté around political context
- Limelight over substance
- Inability to tell a story simply

❖ The facts do not speak for themselves

“10,000 properties thought to be safe went under in Brisbane flood”

Brisbane Courier Mail, March 8th

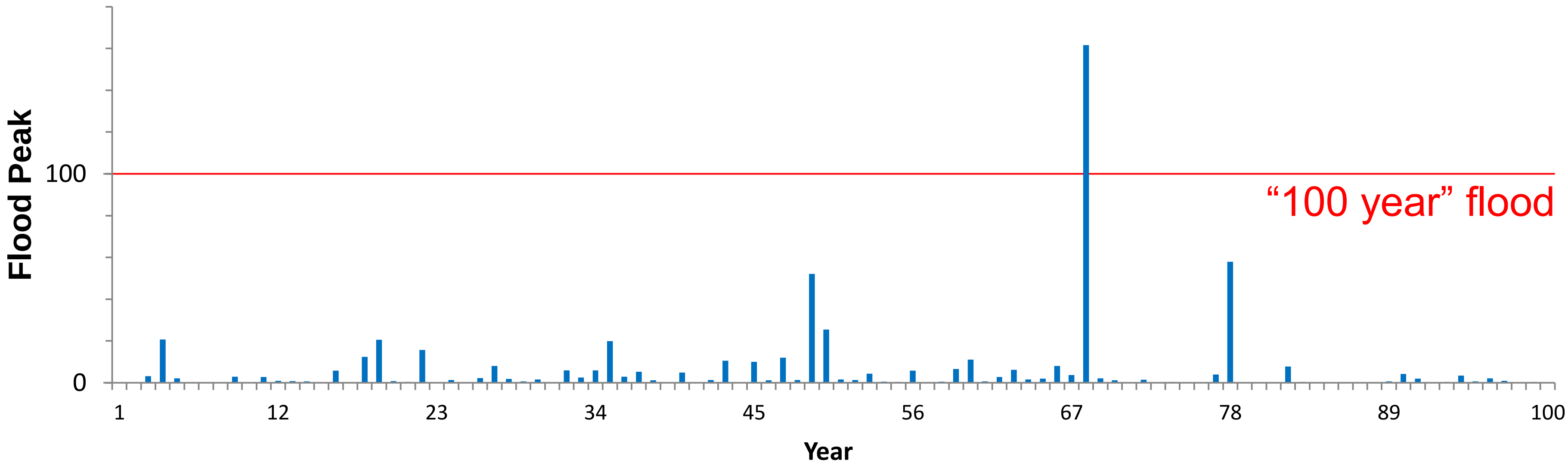
Engineers' Failings

"WRONG Q!"

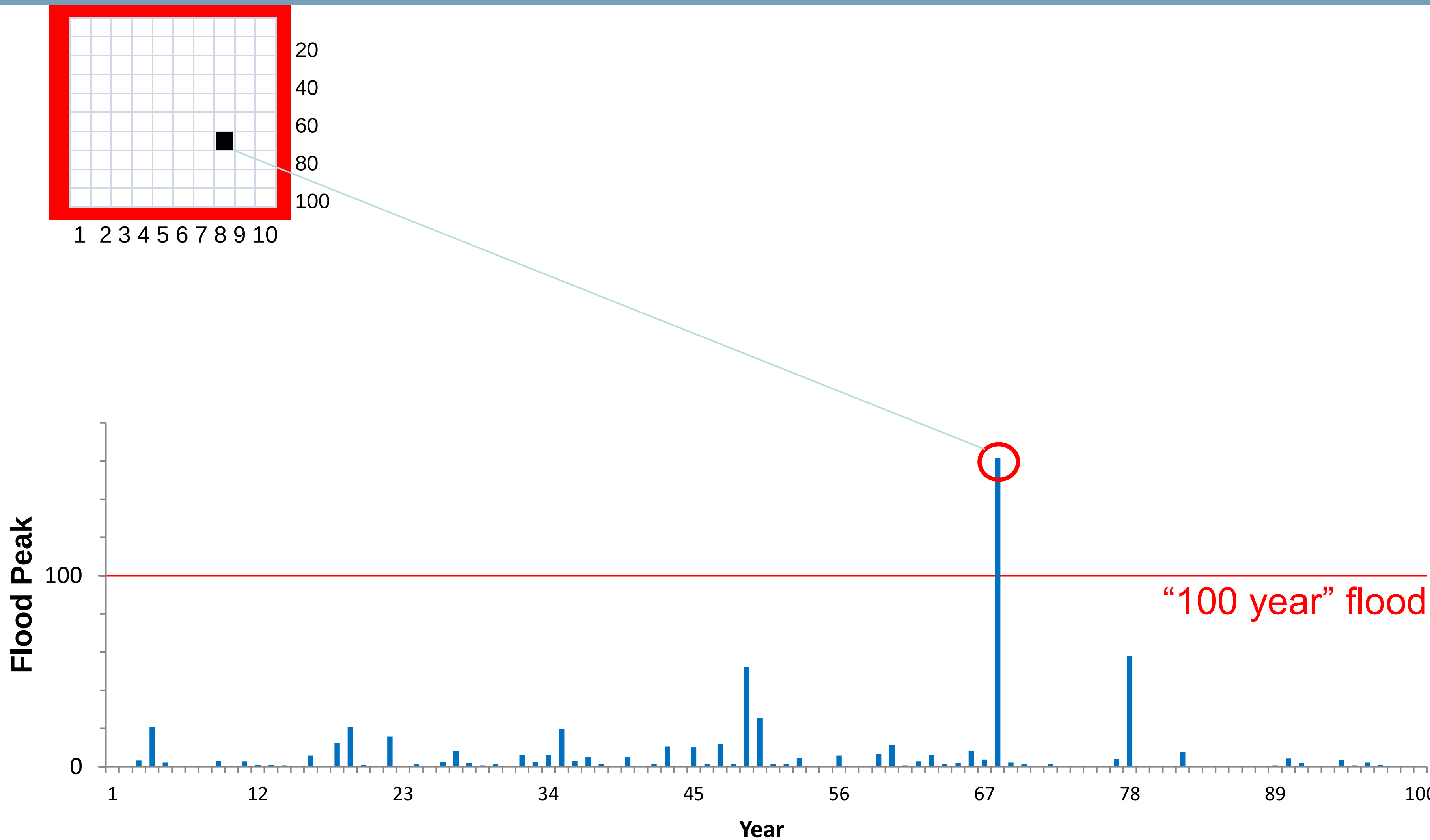
Fallacy of the "100-year flood"

Let's simulate Mother Nature:

- adopt a statistical distribution from the historic record
- set parameters to ensure "100 year flood" = 100 m^3/s
- synthetically generate 100 years of floods
- do this 100 times
- observe different patterns of flood behaviour



Fallacy of the "100-year flood"



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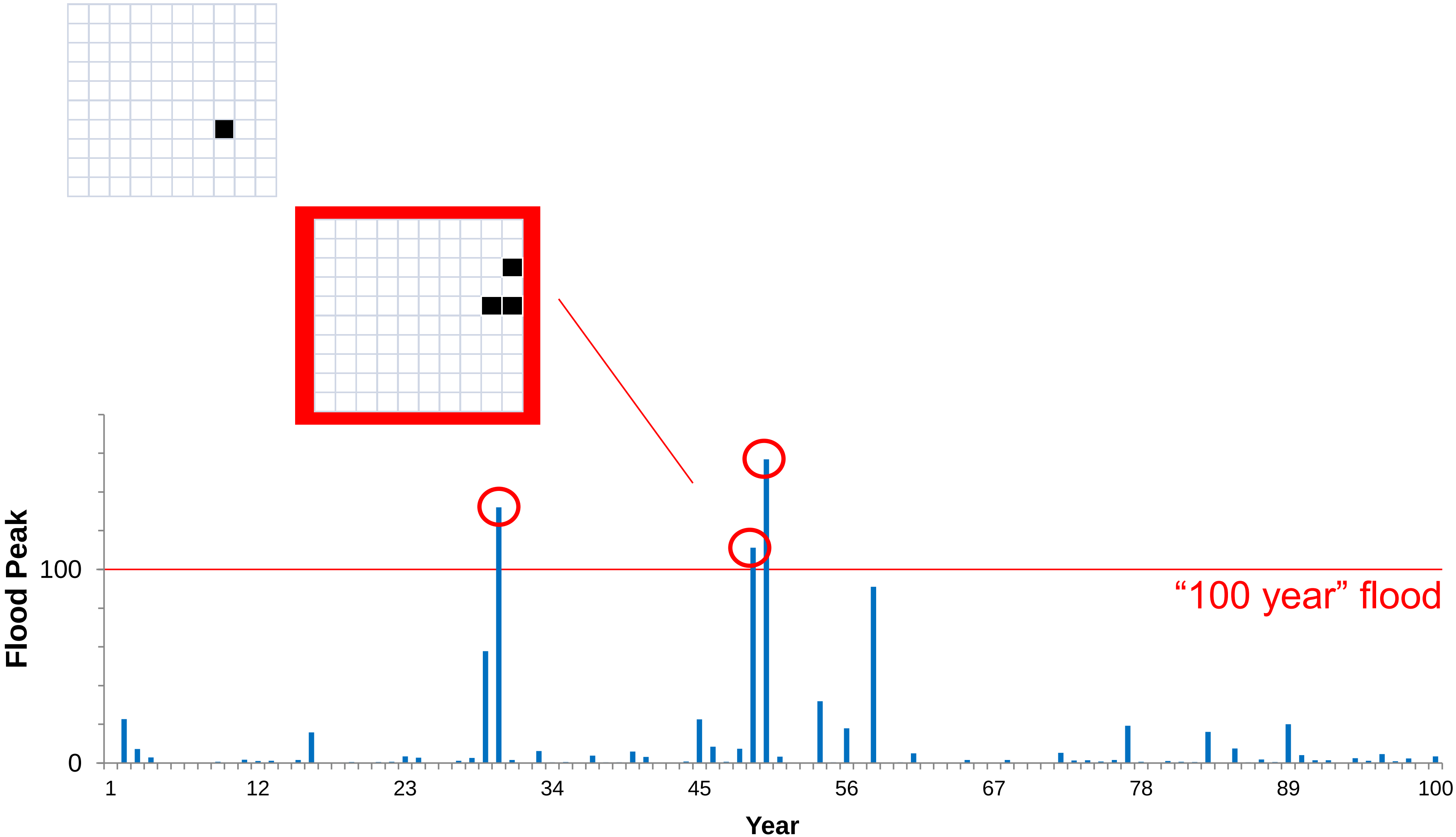

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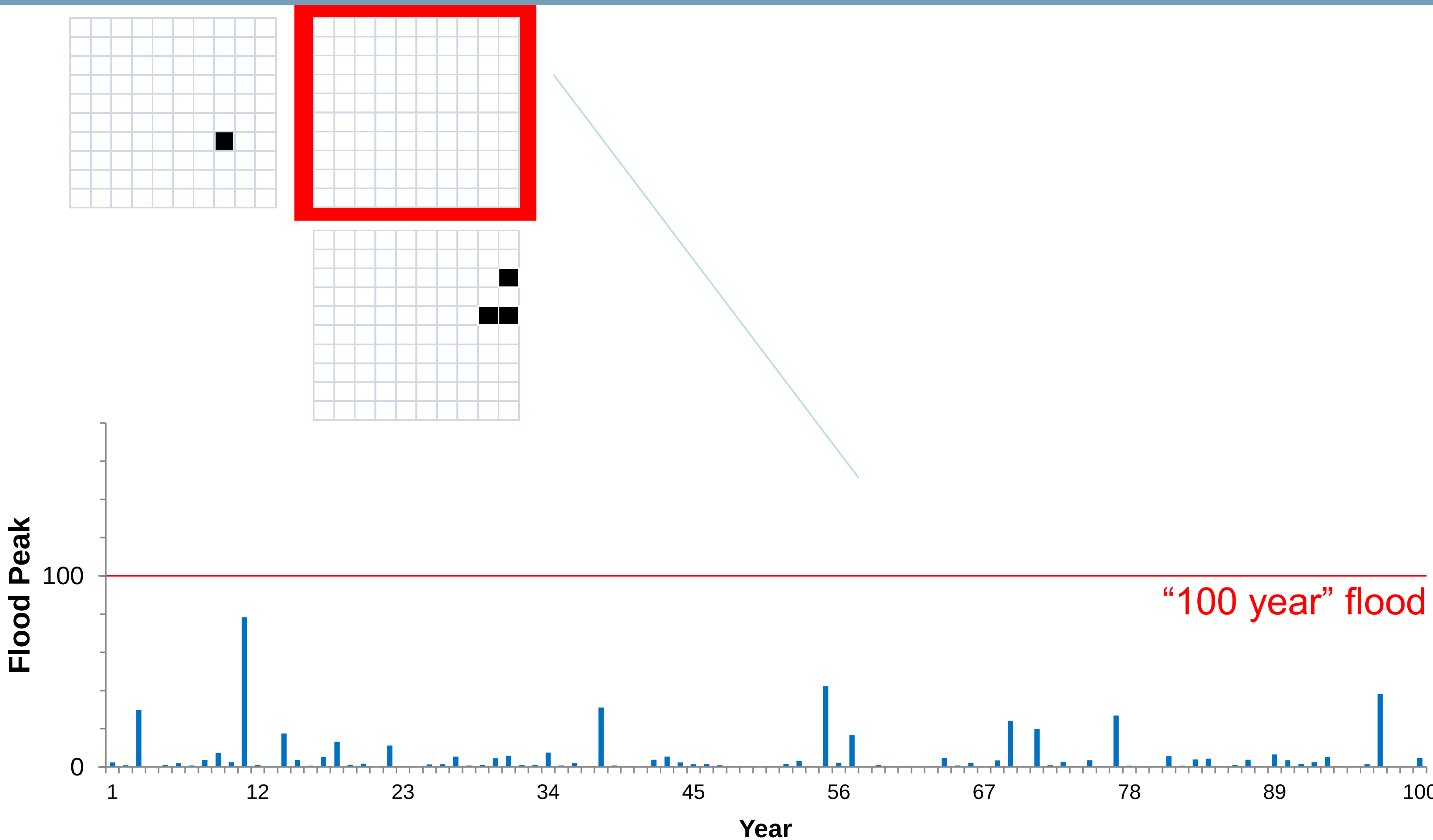
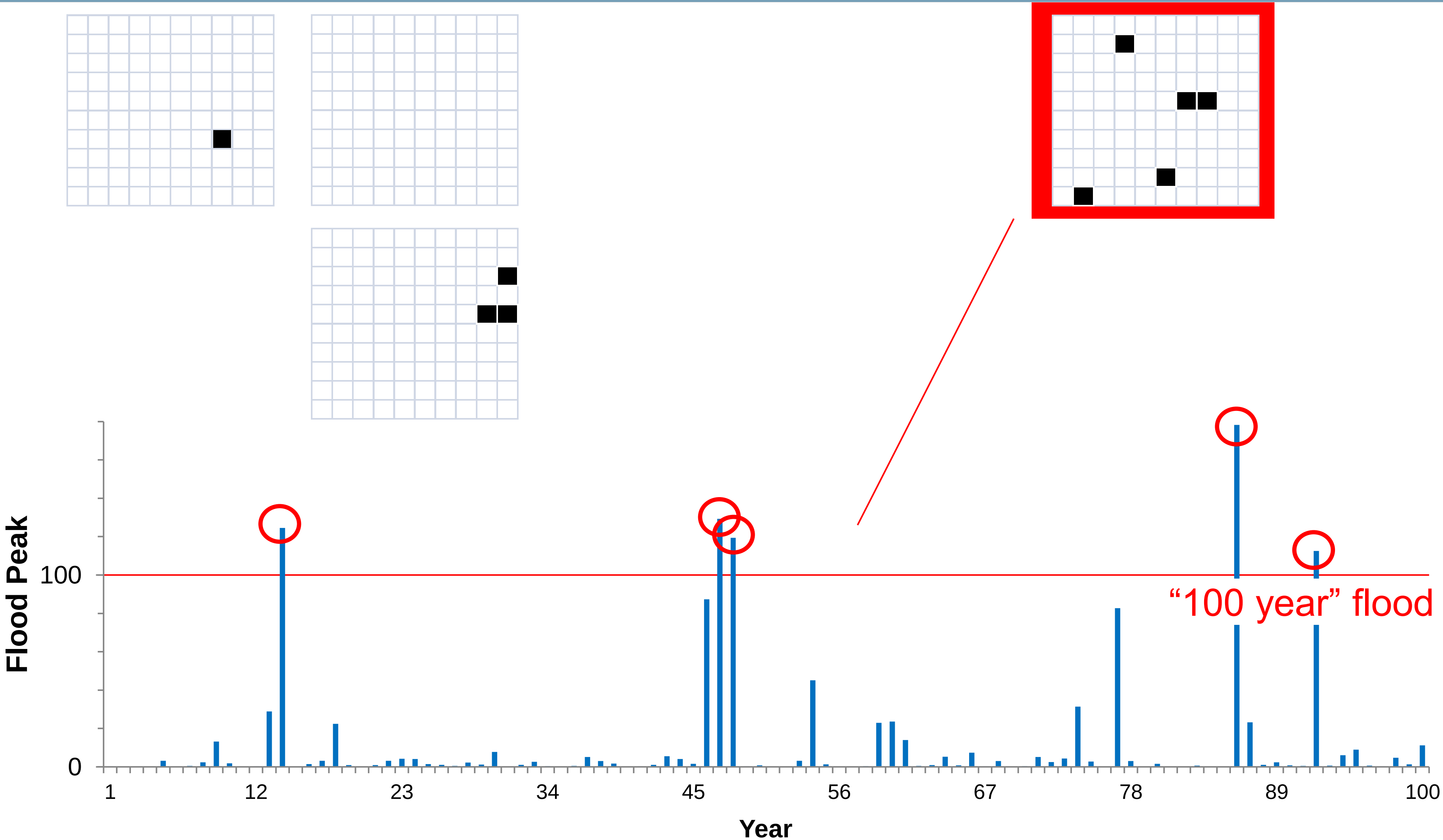
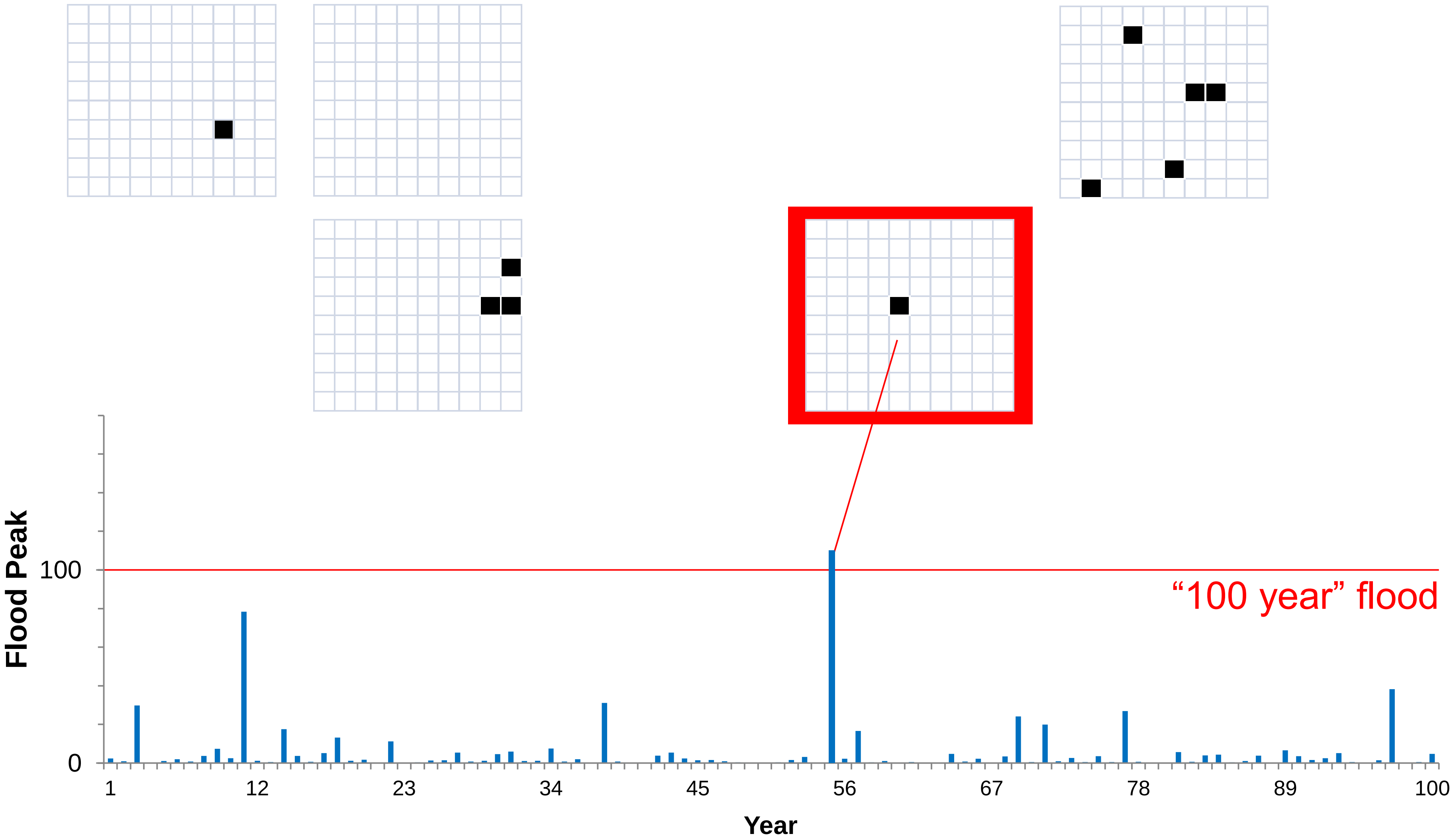


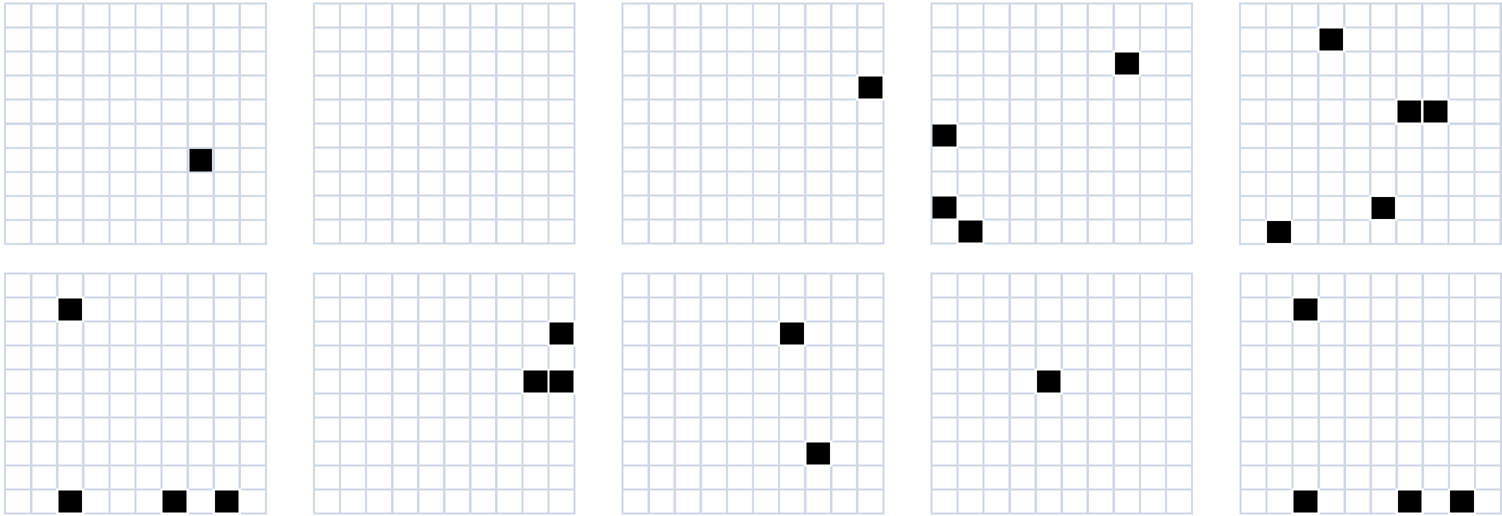
Fallacy of the “100-year flood”



Fallacy of the "100-year flood"



Fallacy of the "100-year flood"



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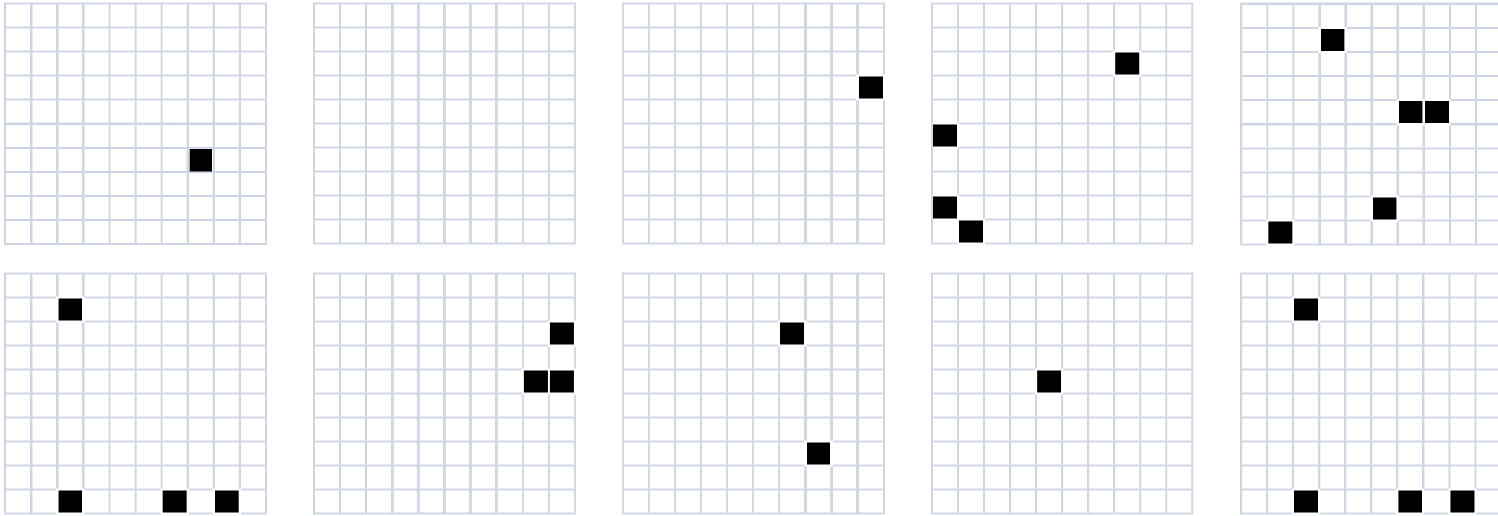
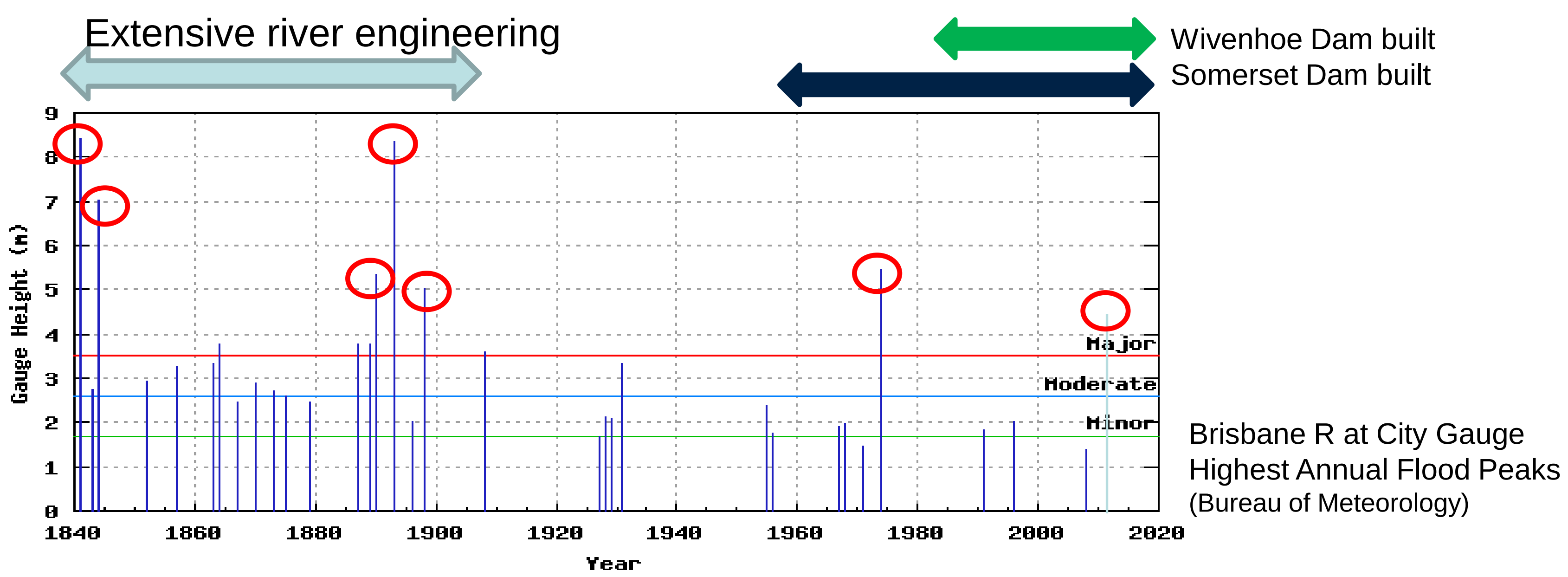




Reality of the "100-year flood"

Number of "100-year" floods, N	Probability that given number of floods occur in 100 years
0	37%
$\geq$ 1	63%
$\geq$ 2	26%
$\geq$ 3	8%
$\geq$ 4	2%
$\geq$ 5	0.3%

- Communicating risk is hard

Dealing with Flood Risk

- Floods are natural and occur at irregular intervals
- Large rainfalls are the most important factor
- **“Flash floods”**
  - Rise very quickly
  - are typically on small catchments
  - are very hard to predict
  - pose a real <u>threat to life</u>
- **“Riverine floods”**
  - occur more slowly
  - are associated with larger catchments
  - can be forecast and predicted
  - pose a <u>threat to property</u> rather than to life

Dealing with Flood Risk

- **Incorrect perceptions:**
  - You are “safe” above the flood planning level
  - Dams, levees, gates (etc) “flood-proof” the community
  - A “100-year” flood only occurs once in 100 years
  - If the “100-year flood” is exceeded then someone is to blame
- **In reality:**
  - There is always residual risk
  - It is a risk you are exposed to every year
  - The bigger the rainfall, the fewer the options to mitigate
  - Engineering (standards-based) approaches alone will fail
  - Strategic (risk-based) adaptive approaches are required

Engineering and Planning Failings

- Acknowledging difference between:
  - "100-year flood" and an "actual event"
  - use of <u>estimation</u> (for risk) and <u>prediction</u> (for forecasting)
- Standards-based vs risk-based thinking
  - "100-year" flood (etc) represents a tolerance for risk
  - it should not be seen as a standard
- Understanding and communication of uncertainty
- Deterministic rather than stochastic methods of estimation (and forecasting)

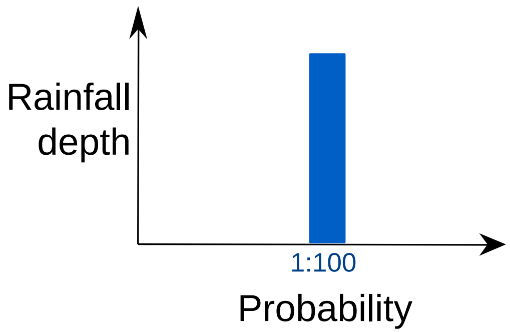
“Q100 Sunk”

“The question is squarely: Is it time to move away from the Q100 mentality towards a different approach to risk management?”

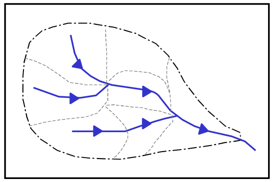
MR P CALLAGHAN SC, Counsel Assisting, 26th Oct 2011

Deterministic Estimates

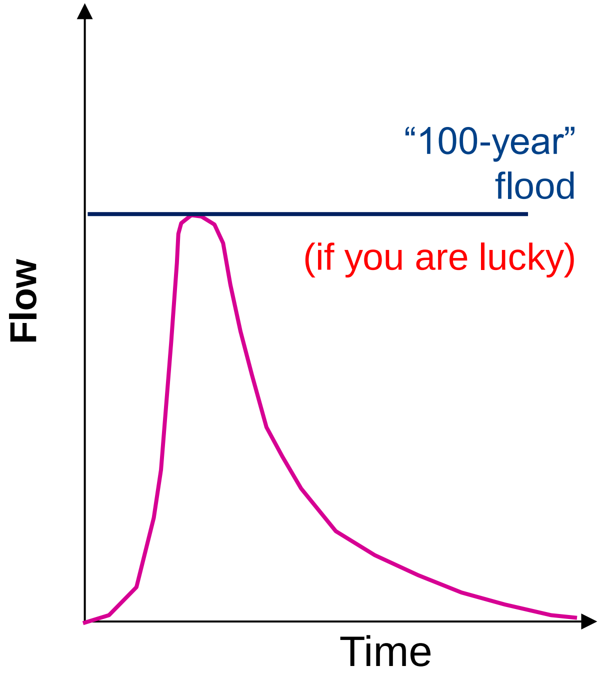
"100-year" rainfall



Flood Model



Flood Estimate



A simplistic act-of-faith divorced from reality

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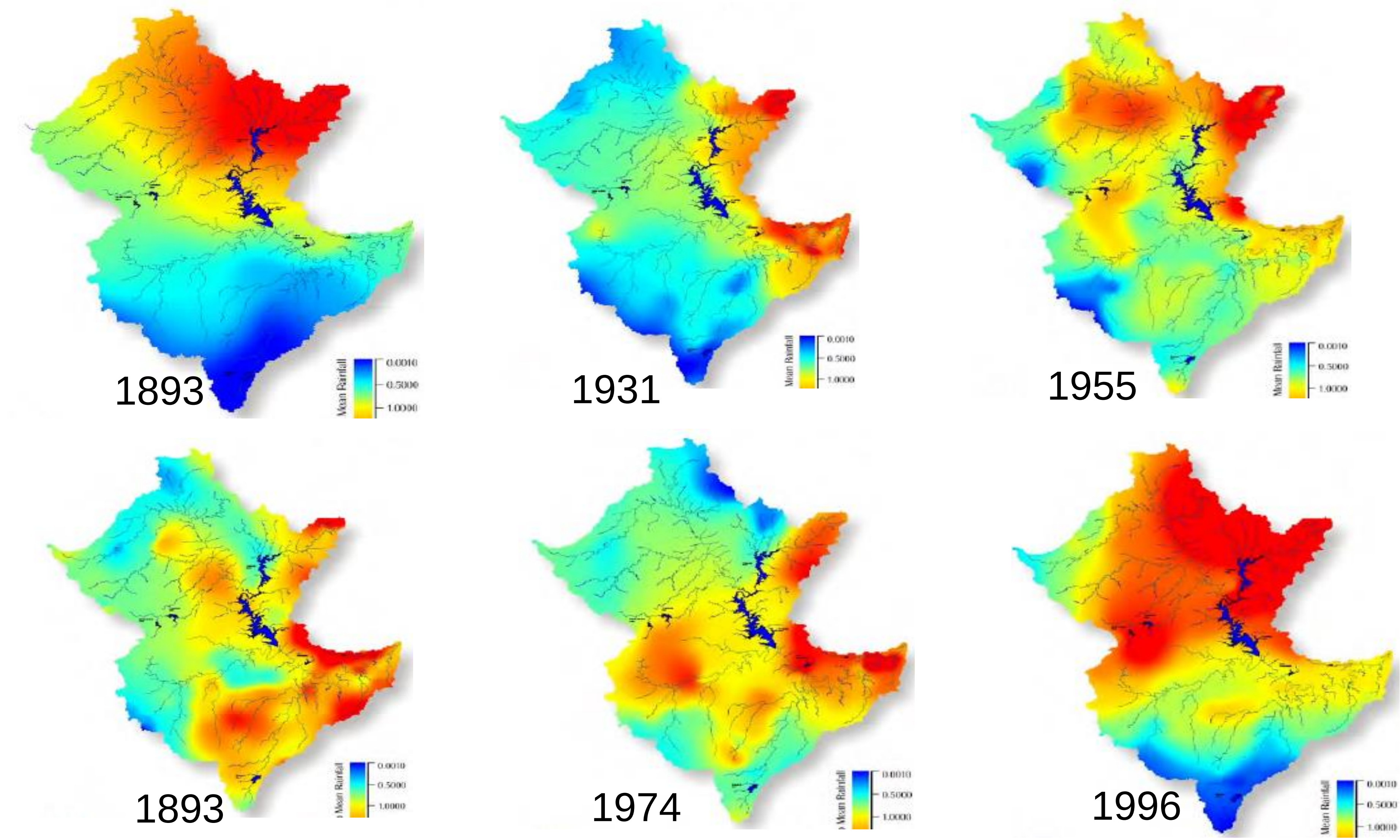
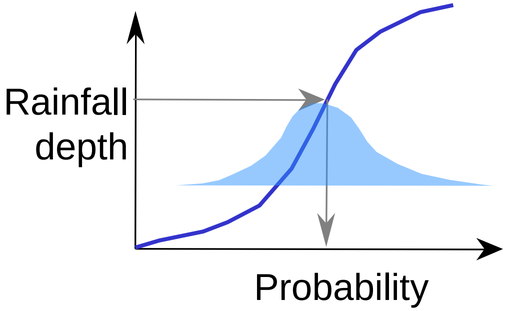
Different storms of same depth can yield markedly different floods

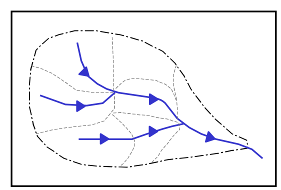


Stochastic Estimation

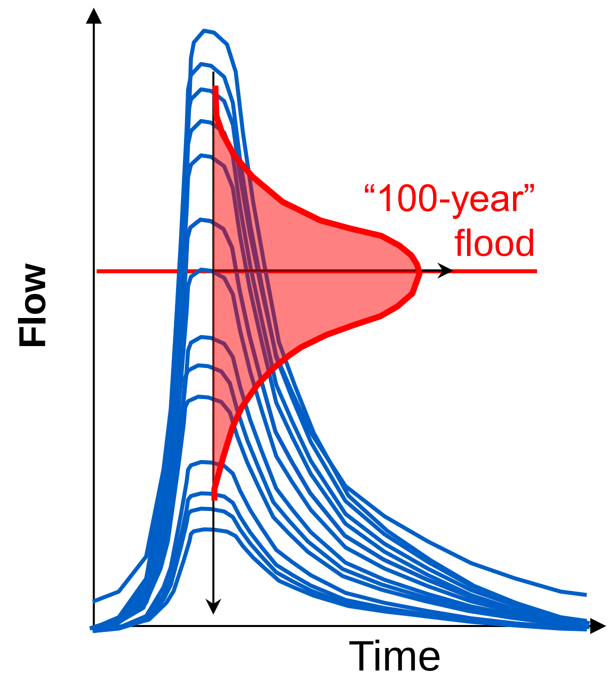
“100-year” rainfall



Flood Model



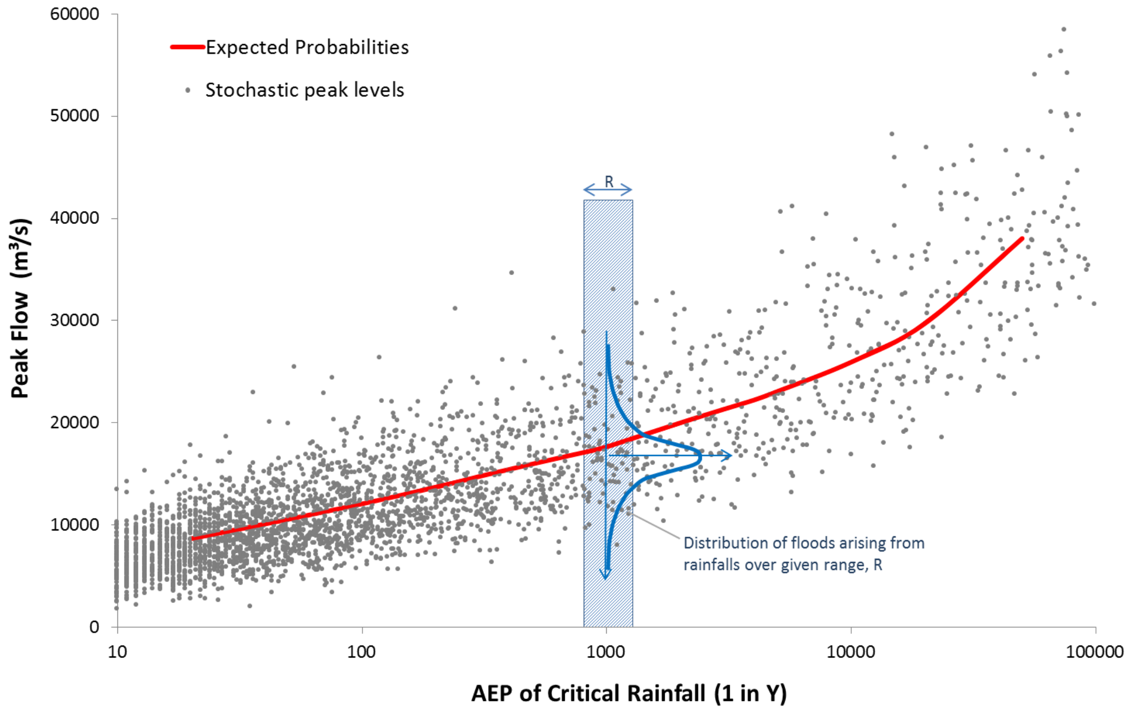
Flood Estimate



Statistics used to mimic randomness of Mother Nature

Stochastic Estimation

❖ (Hydrologic) complexity cannot always be ignored



- It is often necessary to consider joint probabilities in an explicit manner

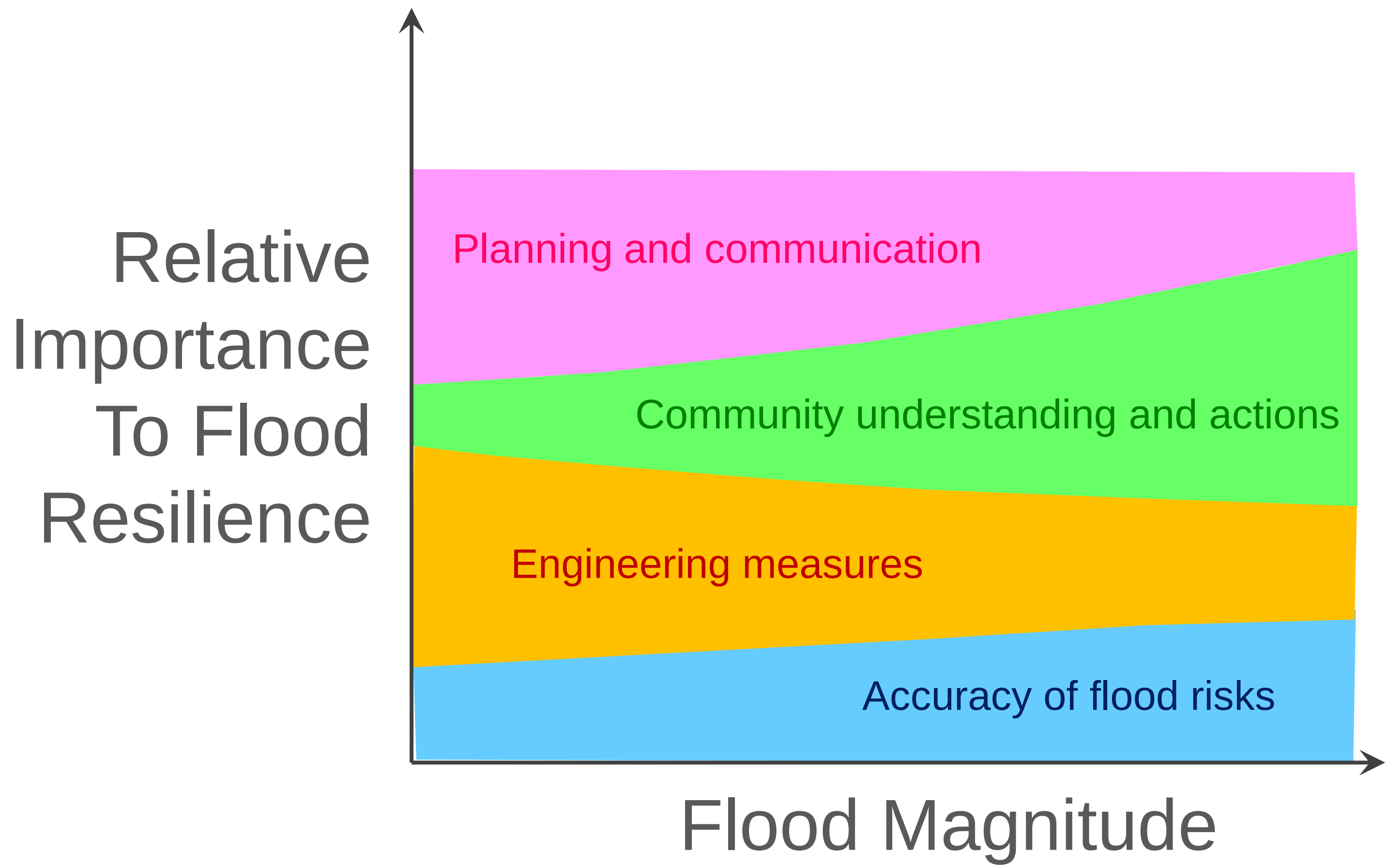
Nathan, R.J., Weinmann, P.E. and Hill, P.I. (2002): Use Of A Monte Carlo Framework To Characterise Hydrological Risk, *ANCOLD Bulletin* - Issue No. 122, 55-64.

10 Golden Rules to Promote Resilience

1. Accept absolute protection is not possible
2. Promote some flooding as desirable
3. Base decisions on understanding of risk and uncertainty
4. Recognise the future will be different from the past
5. Use portfolio of responses rather than single measure
6. Use limited resources efficiently and fairly
7. Be clear on responsibilities for governance and action
8. Communicate risk and uncertainty effectively and widely
9. Engage with stakeholders
10. Reflect local context and integrate with other planning

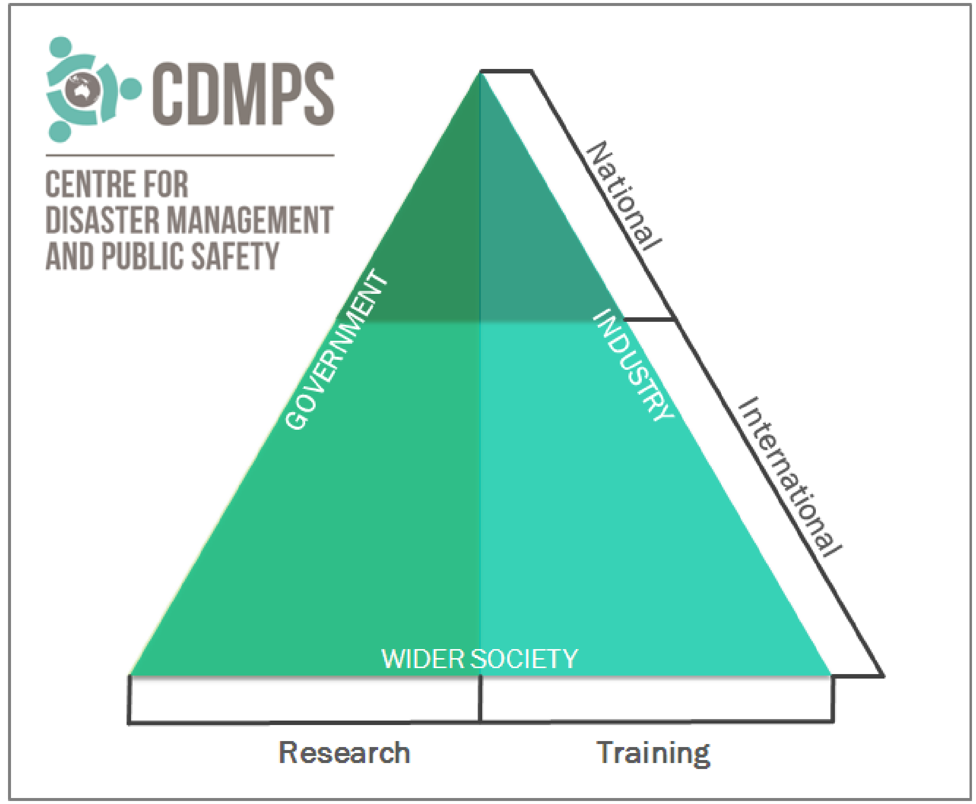
Sayers et al (2014): Strategic flood management: 10 golden rules to guide a Sound approach, *Int J River Management* DOI: 1080/15715124.2014.902378

Relative factors in flood resilience



CENTRE FOR DISASTER MANAGEMENT AND PUBLIC SAFETY

- Multi-disciplinary
- All hazards and all phases of disaster management
- Global themes and engagement



CDMPS

Research **Training**

Launched by University of Melbourne in April 2014

Research Priorities

- ***Priority Area 1:***
  Understanding Natural Disasters
- ***Priority Area 2:***
  Enhanced Decision Making
- ***Priority Area 3:***
  Technology
- ***Priority Area 4:***
  Strengthening Community Resilience
- ***Priority Area 5:***
  Mission Critical Communications
- ***Priority Area 6:***
  Policy

Training

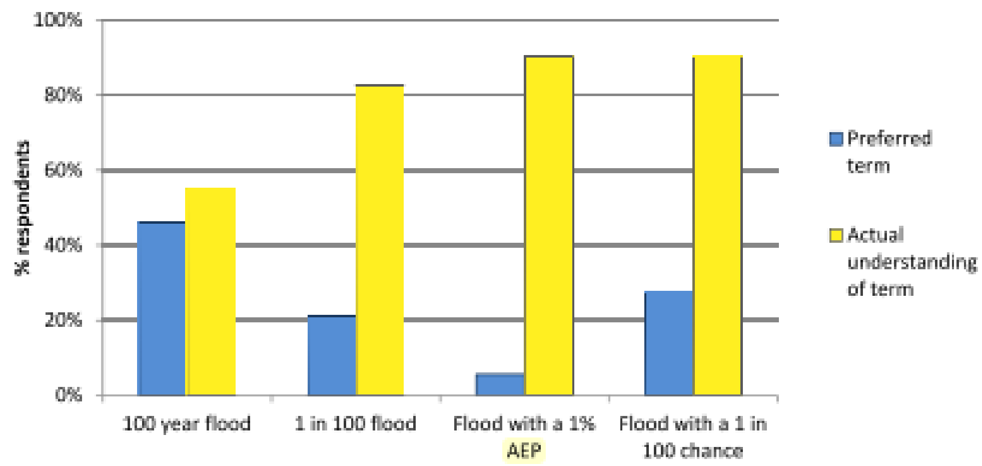
- **Community** Education
- **Intensive** Training
- **Executive** Training
- **Short Courses**
- **Online** Training
- Formal Training: **Masters** level

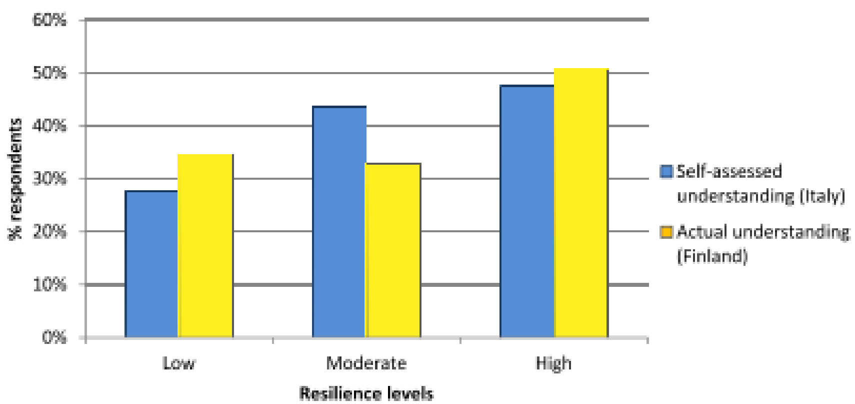
Conclusions

- Absolute flood protection is not possible
- We need to:
  - continuously improve
  - resist early blame
  - stay well within our fields of competence
  - communicate risk clearly
  - cater for uncertainty
- Estimation of complex flood risk is tractable and requires stochastic rather than deterministic techniques
- Strategic flood management requires true understanding of flood risk and rejection of traditional “standards-based” approaches

Enhancing Flood Resilience

Difference between preferred terminology and understanding of flood risk



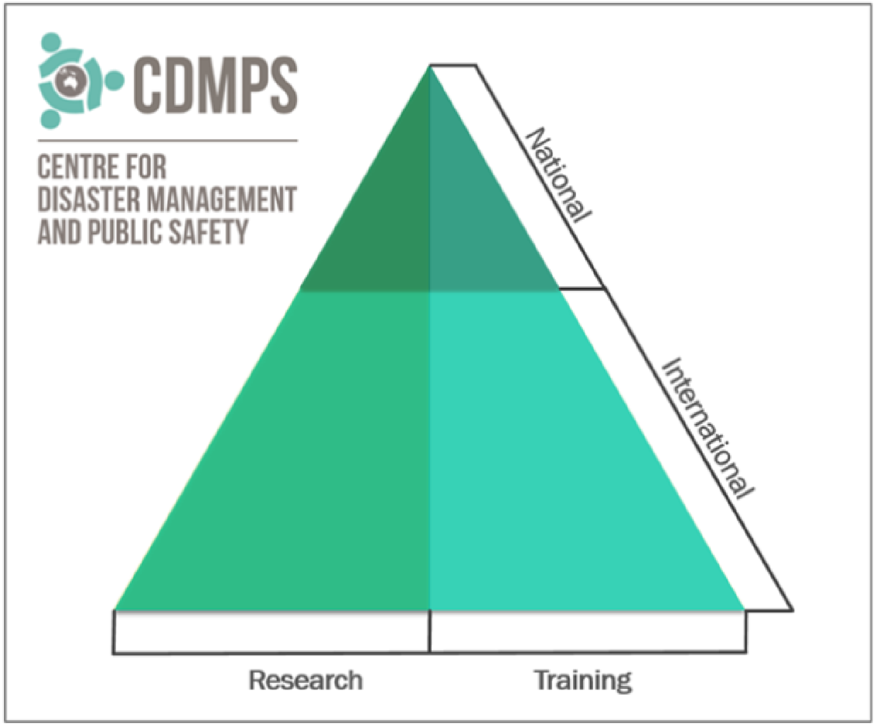


Influence of understanding flood risk on resilience levels (actions, preparedness, worry)

O'Sullivan et al (2012): Enhancing flood resilience through improved risk communications. *Natural Hazards and Earth System Science* 12(7) 2271-2282.

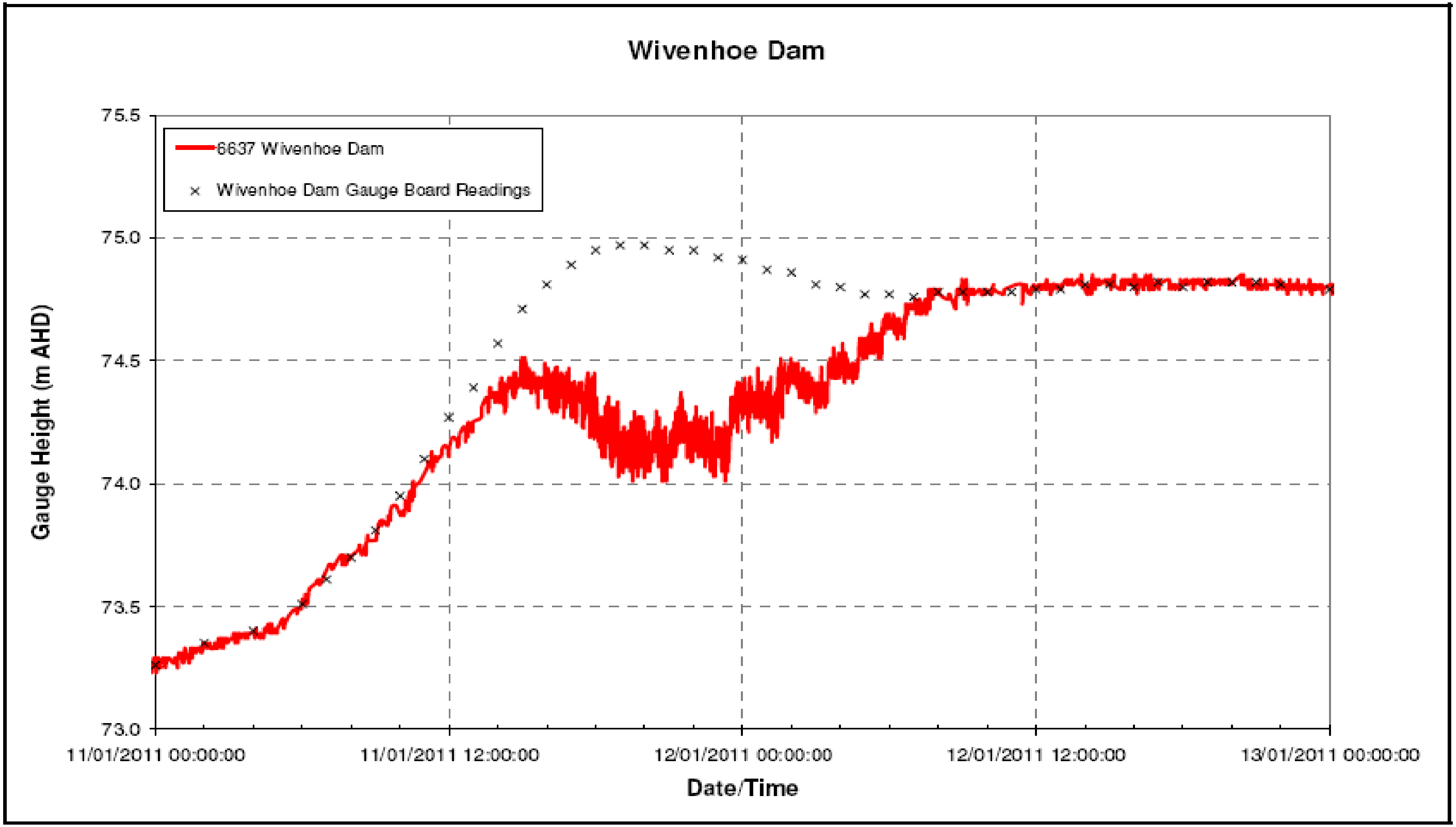
CENTRE FOR DISASTER MANAGEMENT AND PUBLIC SAFETY

- Partners:
  - Association of Public Safety Communications Officials
  - IBM Research Australia
  - AURIN. Australian Urban Research Infrastructure Network
  - Surveying & Spatial Sciences Institute (SSSI)
  - Institute of Transport Studies (Monash)
  - University of Melbourne Emergency Services Club
  - Gajah Mada University

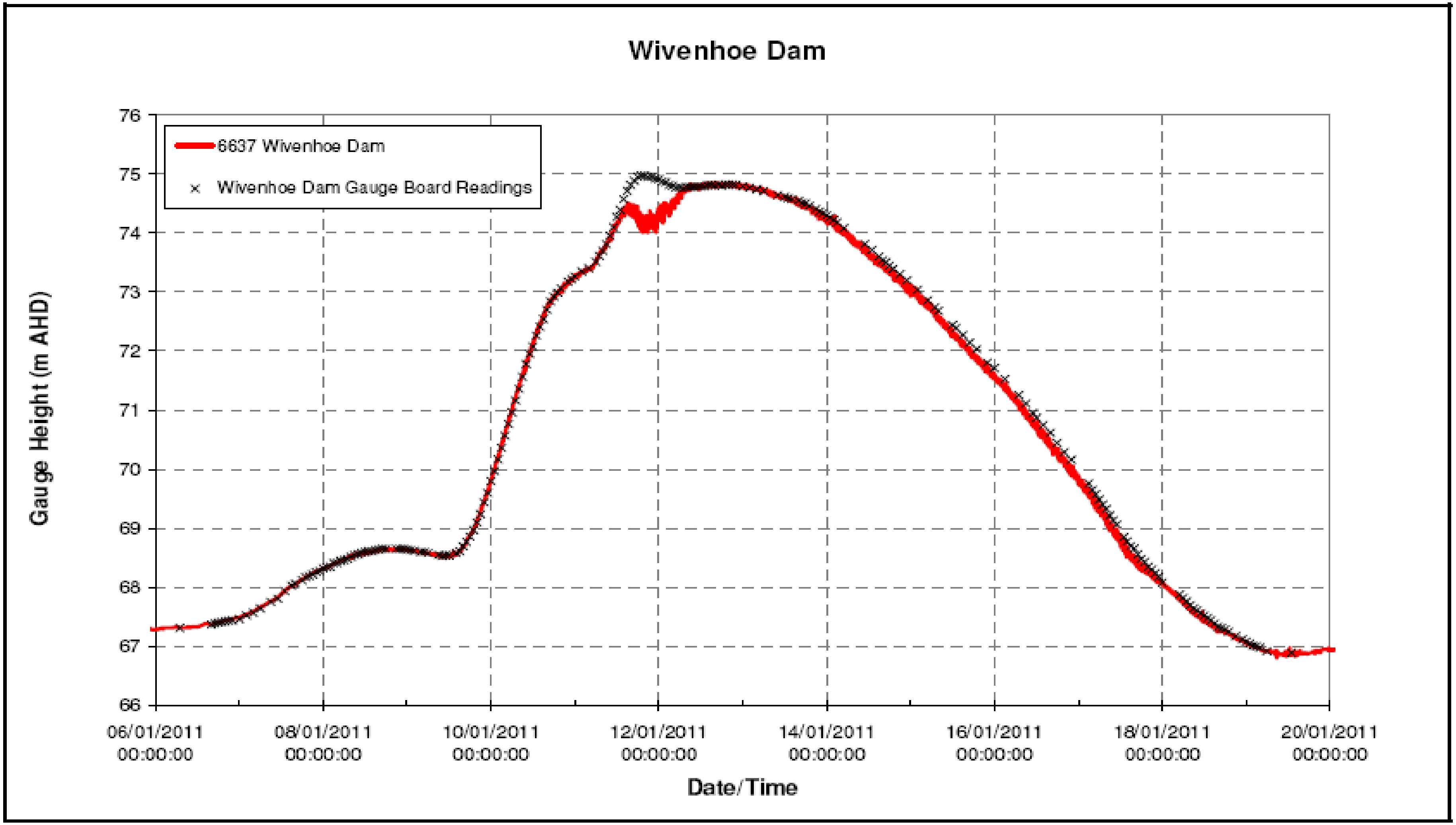


- Supporters:
  - International Federation of Surveyors (FIG)
  - V3 alliance
  - AGL
  - Global Spatial Data Infrastructure Association
  - Edith Cowan University
  - Victoria University
  - Singapore National University
  - Lund University
  - United Nations initiative on Global Geospatial Information Management

Engineers' Failings



Engineers’ Failings



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