South Australian Floods of January 2022 – Hydrology and Consequences

Dr David Kemp

Adjunct Senior Research Fellow - UniSA

OUTLINE

- What is the impact of flooding on infrastructure?
- Have there been similar extreme floods in the past?
- How do arid and semi-arid climates affect runoff?
- Getting a better understanding for design.
- Summary

IMPACT ON INFRASTRUCTURE

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- Roads and railways are vulnerable to flooding
  - By overtopping or longer term inundation
  - Culverts and floodways can be blocked
  - Seals can be lifted – noting that negative pressures often happen on the road surface
- Railways are particularly vulnerable, as ballast can be easily washed away
- Long term flooding in trapped low points is not easily repaired or bypassed

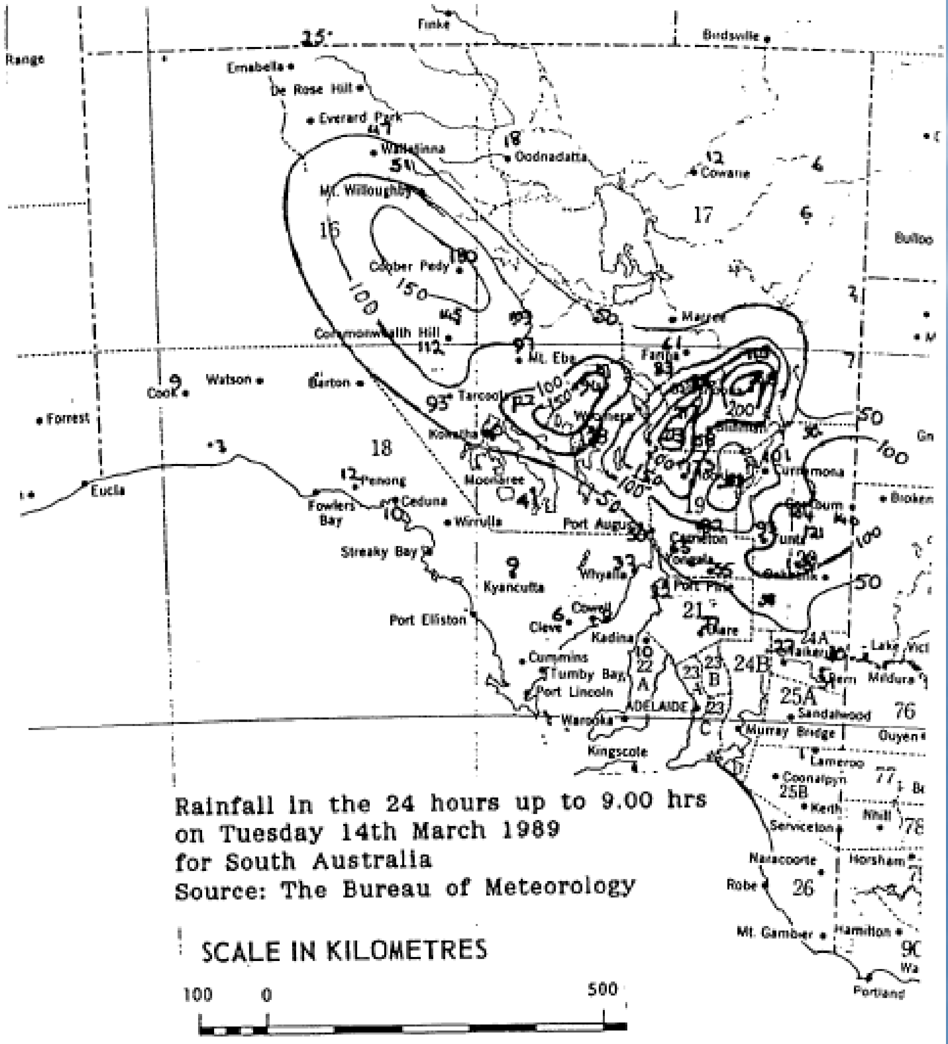

23/01/2007

HAS THIS SORT OF EVENT HAPPENED BEFORE?

OTHER LARGE EVENTS

February, 1989

- Still holds 24 hour and monthly record for South Australia
- 676mm in a month at Balcanoona
- 273mm in 24 hours at Motpena
- Rainfall intensities were generally quite low – the event lasted from 24 to 60 hours
- Considerable damage to the Leigh Creek railway and road
- Only significant problem on Stuart Highway was at Eucolo Creek, flows estimated to be in excess of 100 year ARI

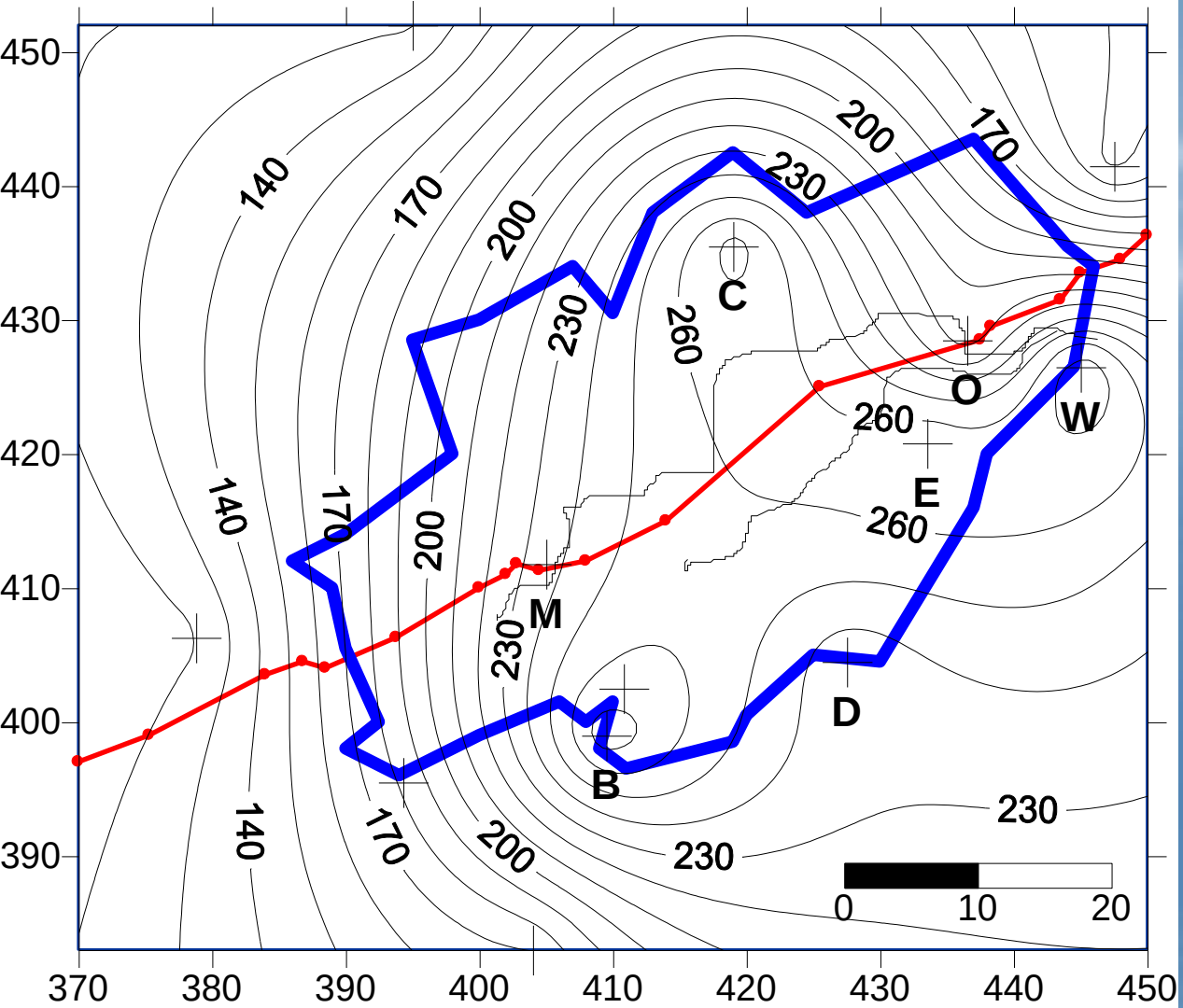


Rainfall in the 24 hours up to 9.00 hrs
on Tuesday 14th March 1989
for South Australia
Source: The Bureau of Meteorology

OTHER LARGE EVENTS

Olary February 1997

- Summer thunderstorms.
- 3 day Rainfalls up to 320mm
- 6hr rainfalls up to 240mm, with Olary Creek catchment having mean of 180mm approximately (1/2 PMP)
- peak flow in Olary Creek (catchment area 1700km^2) of about 5600 m^3/sec (1/2 PMF)
- A very fast catchment response that could be due to influence of surface runoff.



2 day rainfall totals (mm)
Olary Creek Catchment

OTHER LARGE FLOODS

Hawker Area 2007

- Rainfall data around Hawker sourced from BOM, local residents
- Most of the rainfall occurring from early on Saturday morning (1am) until early afternoon (1pm), a period of 12 hours
- the maximum rainfall recorded is estimated to be 180mm at Yednalue, 15km east of Cradock. This is estimated to have an Average Recurrence Interval (ARI) of the order of 1 in 1000 years.
- The average rainfall on the Wonoka Creek catchment on the Hawker to Wilpena Road for the same period was probably of the order of 120mm to 140mm, which is between 200 and 500 years ARI

OTHER LARGE FLOODS – IN SUMMARY

- So, in my experience I have seen a few floods that can be considered to be “extreme”
- Just goes to show that over an area as large as the north of South Australia flooding is quite common.
- Note the “long railway” issue, that for a road the length of the Stuart Highway the chance of exceeding the design flood event somewhere along the road is quite high, depending if the year is a wet or dry year, and the type of rainfall event.

WHY IS FLOODING IN THE NORTH MORE SEVERE THAN IN THE MOUNT LOFTY RANGES?

DESIGN RAINFALL INTENSITIES

Location	3 hour, 1% (mm)	6 hour 1% (mm)	24 hour 1% (mm)	Annual (mm)
Glendambo	60.5	75.1	120	180
Adelaide	61	73.4	100	530
Kimba	56.7	71.6	103	350

RUNOFF PROCESSES

- Three runoff processes have been identified;
  - Baseflow, caused by groundwater discharge into streams
  - Interflow, through surface layers
  - Surface flow, where rainfall intensities exceed infiltration capacity
- In arid and semi-arid areas surface flow dominates, in more humid areas the other two play a more significant role.
- Surface sealing can occur in some soils

IMPLICATIONS OF RUNOFF PROCESSES

- In the north, flows happen less often because high rainfall intensities are needed to generate surface flow.
- Even if stream flows are measured long term, their high variability makes it is more difficult to assess flow probability
- The response time of surface flow is much less than baseflow or interflow
- For most of the state flows are just not measured, as there is no water resource benefit

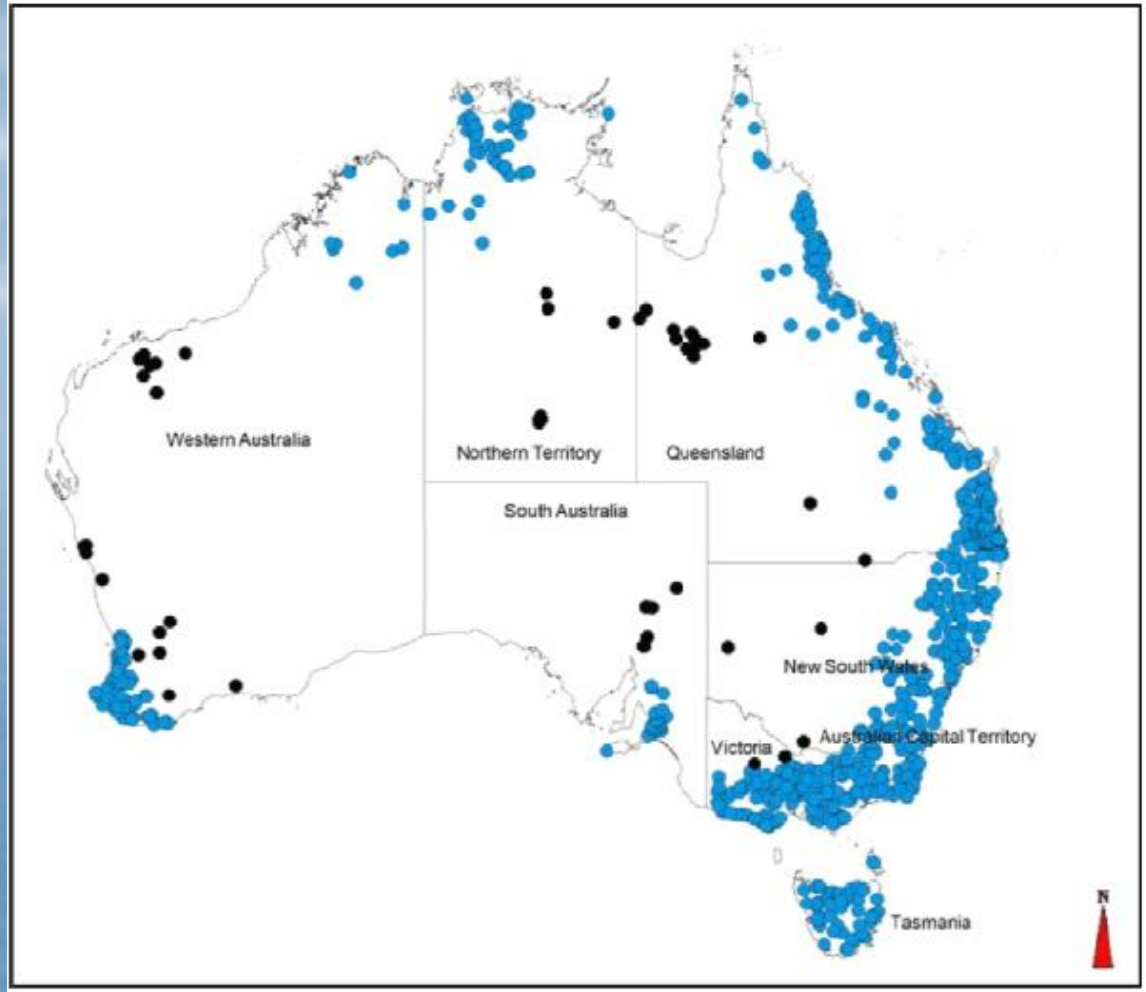


Figure 3.1 Geographical distribution of the selected 853 catchments (data-rich and arid areas)

SOME THOUGHTS

- The unexpected does happen.
- Catchment behaviour during extreme events may not be predictable by the history of common events.
- Current engineering practice may not be valid (can you extrapolate from common events to extreme events?).
- However we do not (and will probably never) have any better methods.

DESIGNING FOR FLOODS

DESIGNING FOR FLOODS

- The consequence of flooding determines the overall risk.
- For floodways on roads the risk is not high, as for properly designed floodways the road is usable straight after the flood has receded
- However for roads and railways designed to be serviceable to a certain standard, like the Stuart Highway or the Alice Springs and WA railway to, damage can occur as a result of overtopping. This will necessitate repair.
- The greatest consequence is in trapped low points, where the road or railway can remain inundated for long periods.
- This is also the most difficult case to design for.

DESIGNING FOR FLOODS

- In trapped low points there are two issues, the contributing catchment area and the volumetric runoff coefficient.
- The first has been overcome to a large extent now with the development of better terrain data such as LIDAR
- The second is still a great unknown

DESIGNING FOR FLOODS

- Unfortunately there is a great lack of formal evidence of flow history on which to base flood estimates in the north of South Australia
- Australian Rainfall and Runoff (the handbook of Australian Hydrology) has no guidance for most of the State.
- So, what do we base designs on?
- The Stuart Highway and the Alice Springs railway were both designed in the early 1980s, and generally have been performing well.

SUMMARY

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- Floods such as occurred this year are not an infrequent occurrence somewhere in the State
- The impact on rail and road infrastructure is significant
- The consequence of flooding depends on the nature of the infrastructure and the terrain, with trapped low points having the greatest risk.
- There is a lack of information on which to base designs for remote regions.
- This is because of the:
  - Lack of historical evidence such as gauged stream data
  - The possibility that large and extreme floods do not behave like smaller floods.

SUMMARY

- What to do?
  - Continue to document large floods so that historical evidence is available
  - Look at the possibility of importing evidence from other regions that are hydrologically similar
  - Consider fully the consequence of flooding when designing new infrastructure, and setting appropriate design standards taking consequence into account.