CALGARY 2022 CANADA

FEBRUARY 7–11 | 7–11 FÉVRIER | 7–11 DE FEBRERO

Resilient Maintenance Planning in Australia

Tyrone Toole

Chief Technology Leader, Asset Performance

Australian Road Research Board

tyronet@arrb.com.au

VIRTUAL | VIRTUEL

XVI WORLD WINTER SERVICE AND ROAD RESILIENCE CONGRESS

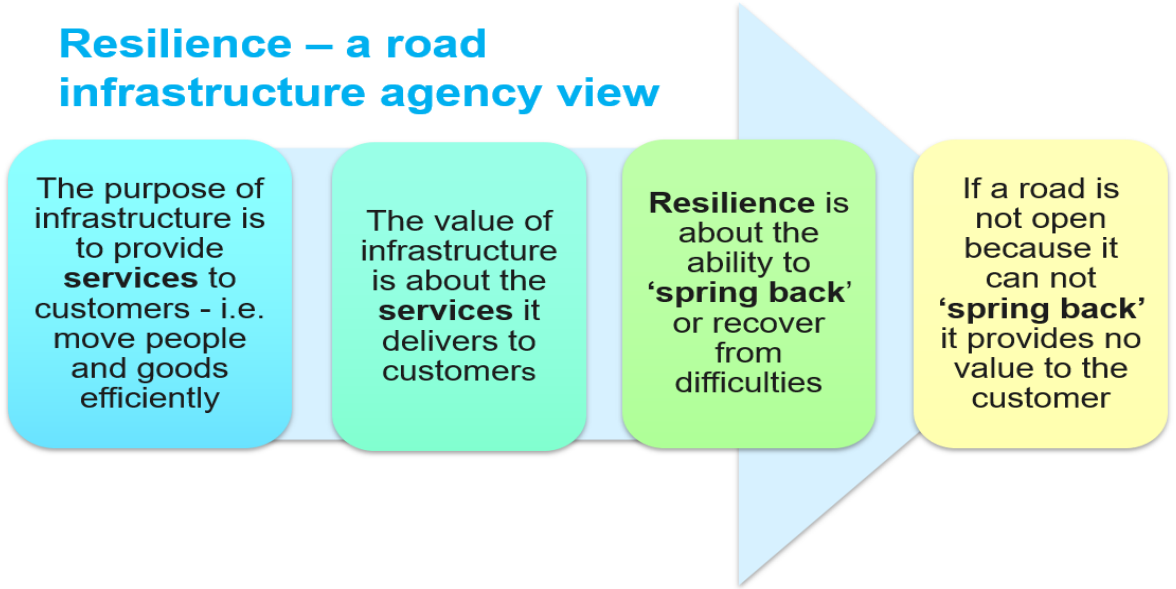
XVI[e] CONGRÈS MONDIAL DE LA VIABILITÉ HIVERNALE ET DE LA RÉSILIENCE ROUTIÈRE

XVI CONGRESO MUNDIAL DE VIALIDAD INVERNAL Y RESILIENCIA DE LA CARRETERA

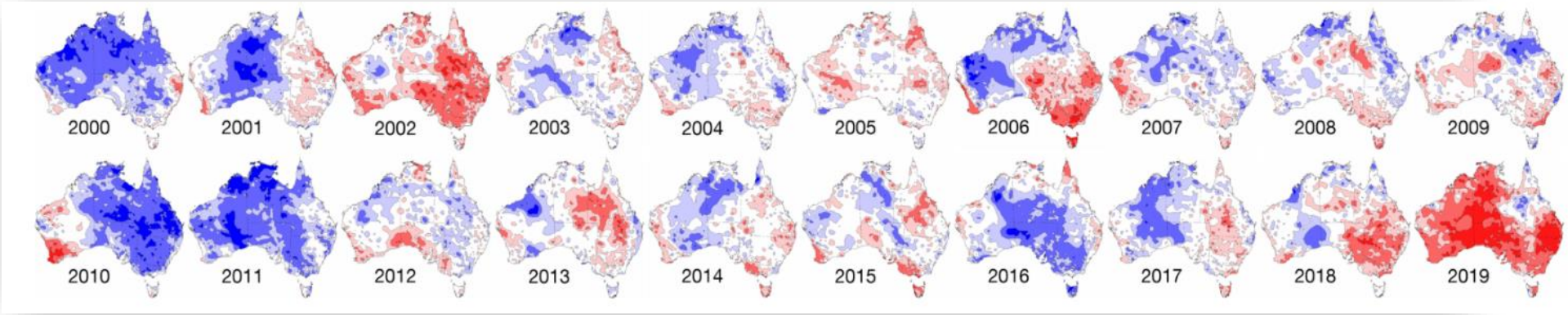
PIARC Calgary Canada

Do we understand our climatic challenges?

1. Have we changed our way of thinking about short-term cycles and long-term trends and taken notice?
2. Have we recorded the magnitude and/or duration of disruptive events and their impact on performance?
3. Have we changed our thinking and approach to anticipate, absorb, adapt to, and/or rapidly recover from disruptive events?

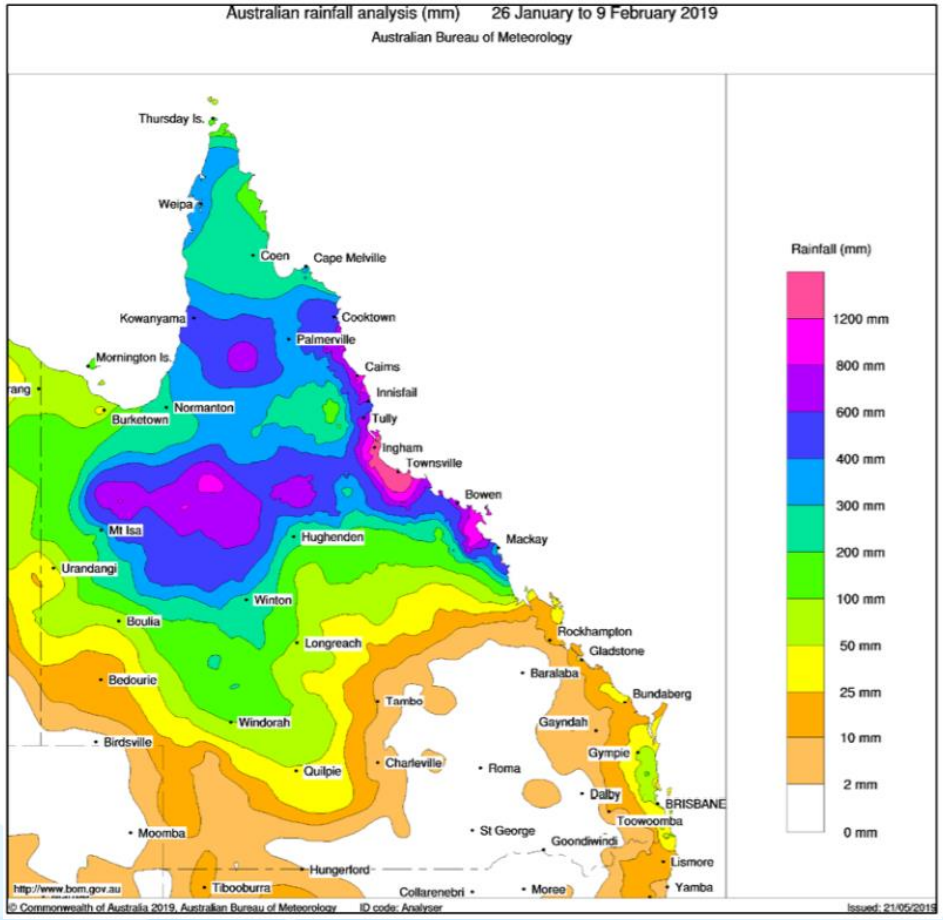


Australia – the land of fire and flood – What happens? – El Nino and La Nina cycles

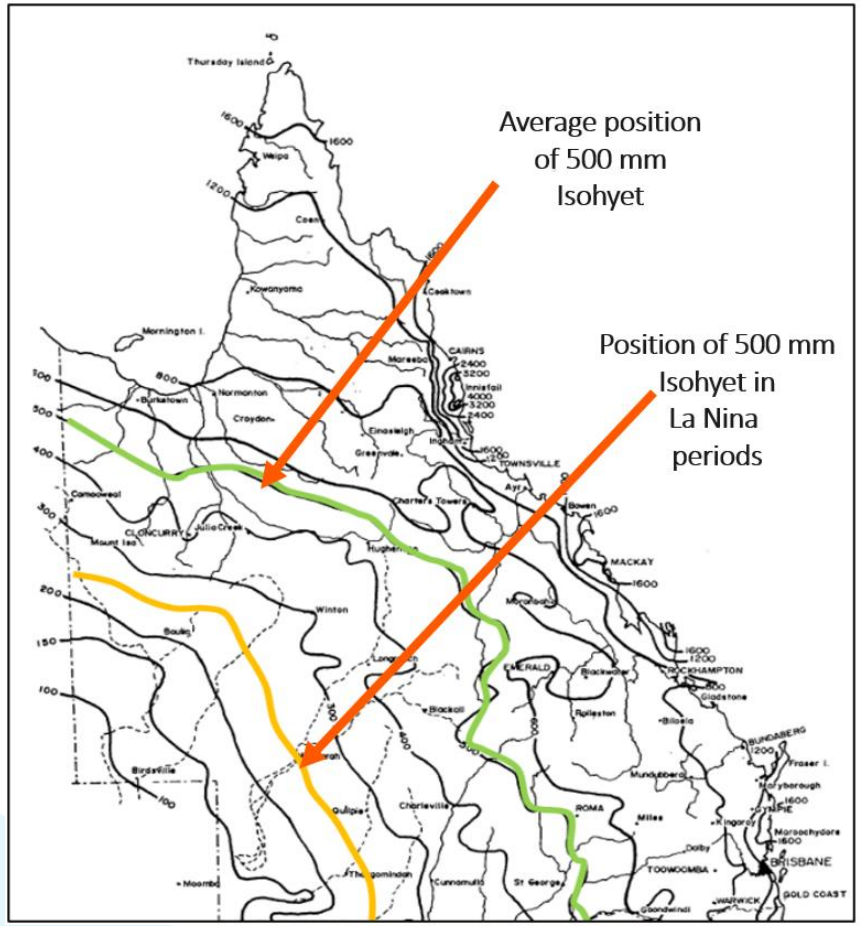


- Increased uncertainty in climate factors
- Lessons from major events
- Large proportion of pavement failures
  - Table drains blocked/inadequate
  - Still many sections ‘waiting to fail
- What are suitable treatments, and where

What does it look like? 2019 Monsoon trough

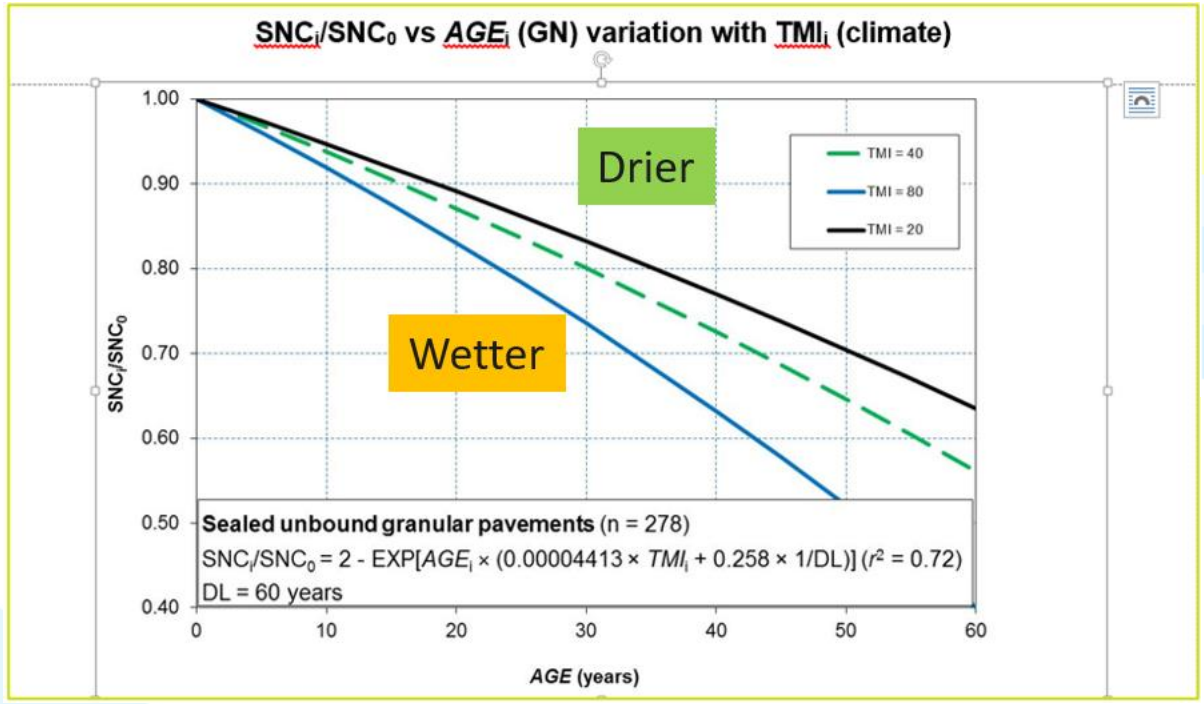


Long-term trends /cycles – are we awake to these?



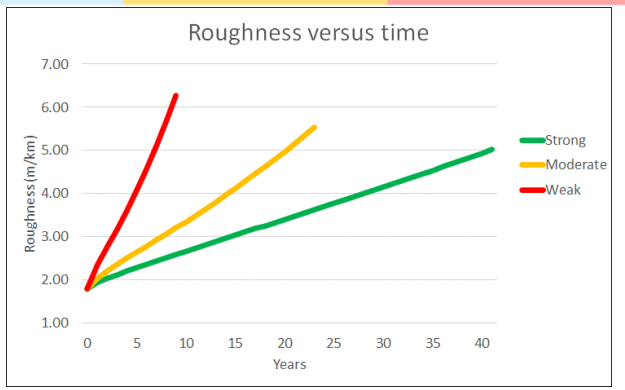
What could performance be like?

How does pavement strength change with climate for designed arterial roads?



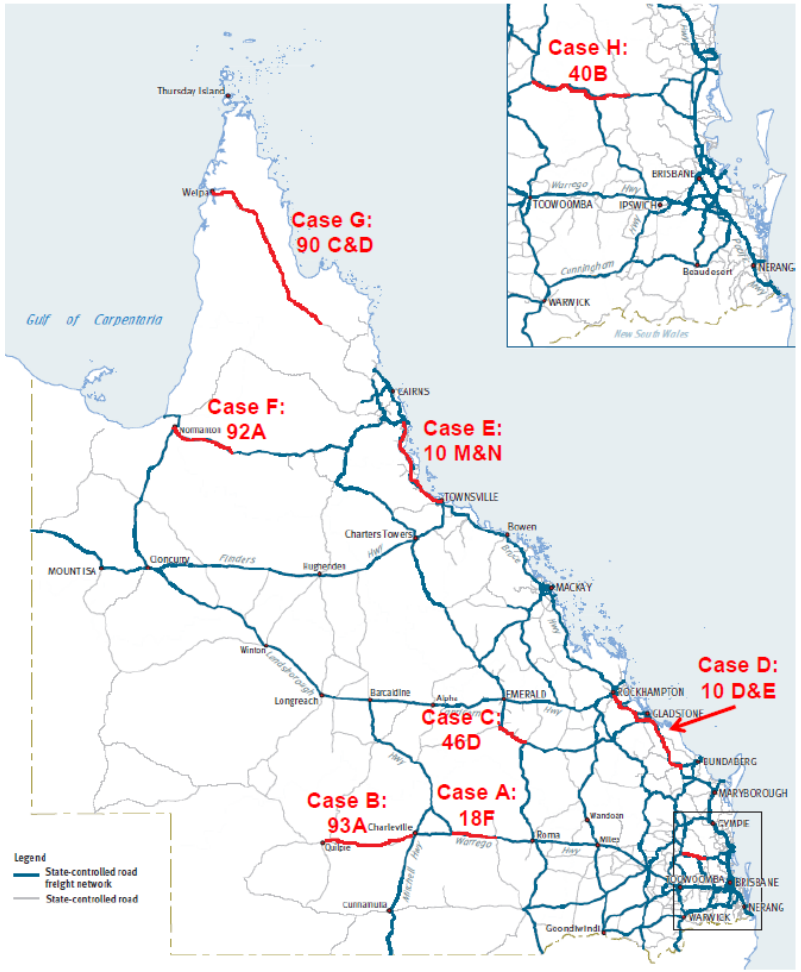
Do we know the impact of varying conditions - low volume sealed road?

Pavement moisture and drainage	Modified structural number (SNC)		
	Standard materials	Marginal materials	Non-standard materials
Dry, well-drained	5.1	5.1	3.2
Dry, poorly drained	5.0	3.1	3.1
Wet, well-drained	3.1	1.8	1.6
Wet, poorly drained	2.9	1.6	1.5



Queensland – Life Cycle Cost of rain & flood events

1. Collected data on the rain/flood events and Transport Network Rehabilitation Program (2010/13)
2. Developed analysis methodology & case study selection criteria
3. Identified seven case studies including background data
4. Investigated gradual deterioration within different environments and recurrence cycles of extreme events
5. Considered preventative ‘stitch-in-time’ strategies and full resilience as alternatives to a reactive (‘business as usual/as-happened’) strategy
6. Accounted for disruption, i.e. reduced access, lower journey speeds, during period of disruption and rebuilding



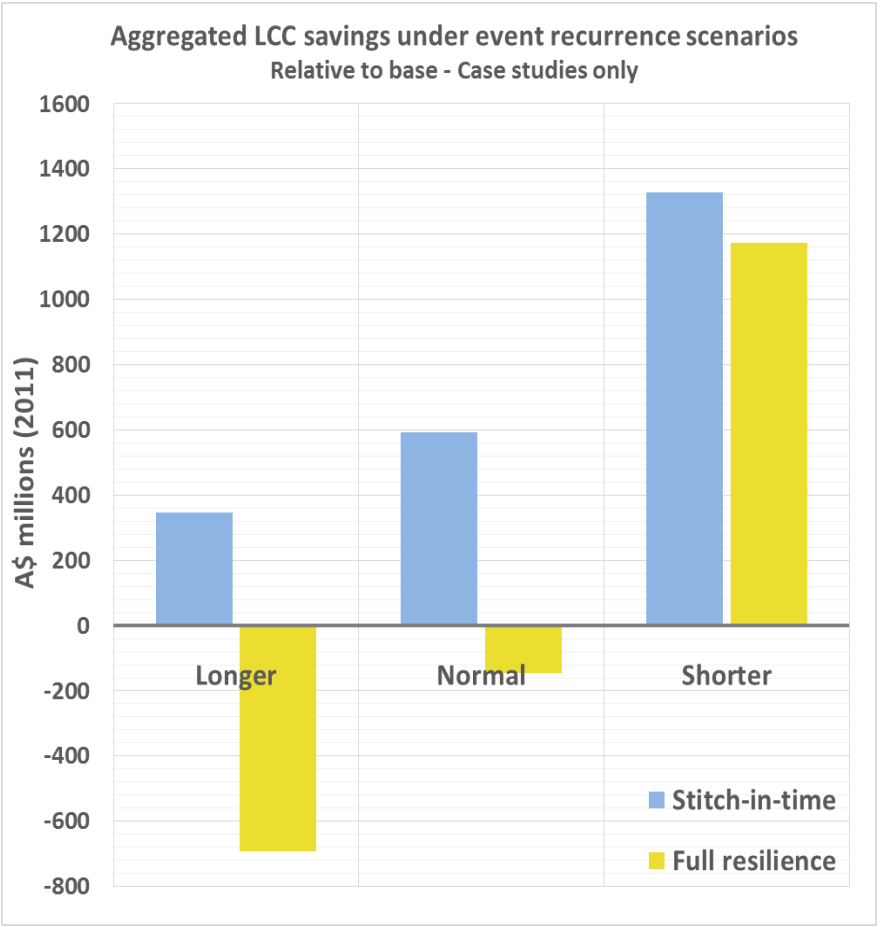
Results by Route Type, Option and Recurrence Interval (PV of TTC)

Overall	Interval	BASE	OPTION 1 Full resilience	OPTION 2 Stitch in time
Major routes (10D,10E,10M,10N)	Long (25 yrs)	$30,159,251,649	$30,631,394,584	$30,003,411,162
	Normal	$30,497,428,885	$30,671,726,755	$30,192,697,534
	Short (5 yrs)	$31,418,134,627	$30,750,196,527	$30,621,676,989
Rural highways (18F, 46D)	Long (25 yrs)	$1,737,265,696	$2,005,934,221	$1,715,166,130
	Normal	$1,797,916,897	$2,006,348,858	$1,755,568,922
	Short (5 yrs)	$2,075,200,366	$2,044,291,592	$1,910,643,269
Development & remote roads (90C,90D,92A,93A)	Long (25 yrs)	$1,928,420,211	$1,880,938,155	$1,760,305,248
	Normal	$2,156,171,671	$1,919,133,580	$1,911,807,303
	Short (5 yrs)	$2,433,467,006	$1,958,448,306	$2,067,605,711
TOTAL	Long (25 yrs)	$33,824,937,556	$34,518,266,960	$33,478,882,540
	Normal	$34,451,517,452	$34,597,209,194	$33,860,073,759
	Short (5 yrs)	$35,926,802,000	$34,752,936,425	$34,599,925,969

	Lowest TTC
	Mid TTC
	Highest TTC

Summary of findings

- Stitch-in-time leads to savings (case studies only)
  - Agency costs same or lower
  - Reduced impact of rain/flood events
- Full resilience generally not advantageous (case studies only)
  - Very high agency costs, not recovered
  - Viable on higher order roads
- Best for network
  - Appropriate mix which maximises savings
  - Net economic savings of $2.7 per additional $
- Spend $6 billion ASAP to future proof



Commentary on modelling components

Components	Actual method	Current HDM-4 equivalent
Vehicle fleet	TMR 6-veh fleet	TMR 6-veh fleet
No. of sections per case study	3 condition x 3 vulnerability = 9	3 condition x 3 vulnerability = 9
Maintenance & improvement standards	• Case study specific • Scheduled road replacement to reflect event occurrence • RM costs based on vulnerability	Case study specific including scheduled road replacement to reflect event occurrence
Traffic flow	• Purpose built to reflect actual & risk	No direct solution available for multiple closures / diversion periods and speed limited periods
Route closure / Diversions	• Varied by option with Base = Actual (A); Full = 20% * A ; S-i-T = 65% * A	
Speed limits	• Varied by option with Base = Actual (A); Full = Nil ; S-i-T = 65% * A	
Speed flow types, Accident classes, Climates	Austroads/Auslink HDM-4	Austroads/Auslink HDM-4
Calibration sets	• TMR pavement type, road class and moisture zone/soil reactivity • Vulnerability modelled by adjusting Kgm (moisture enviro) and Kgs (structural) calibration factors	As TMR

Lessons learnt from 2010–13 period

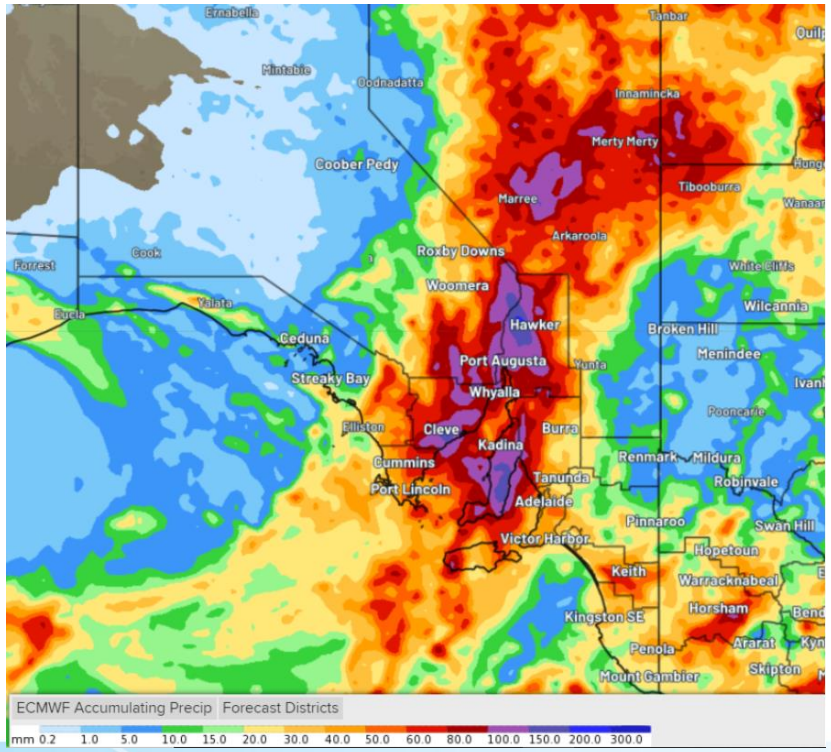
- Similar events are likely in the future
- Strategies must consider the future likelihood of major weather events
- Whilst results by case study are case specific, further modelling has shown:

Major routes	Rural highway network	Development roads and remote links
• benefit from high investment to create fully resilient pavements • considerable value in maintaining access	• need assessment for vulnerability • critical routes benefit from increased resilience • targeted investment	• too expensive to impart full resilience • important to maintain basic connectivity

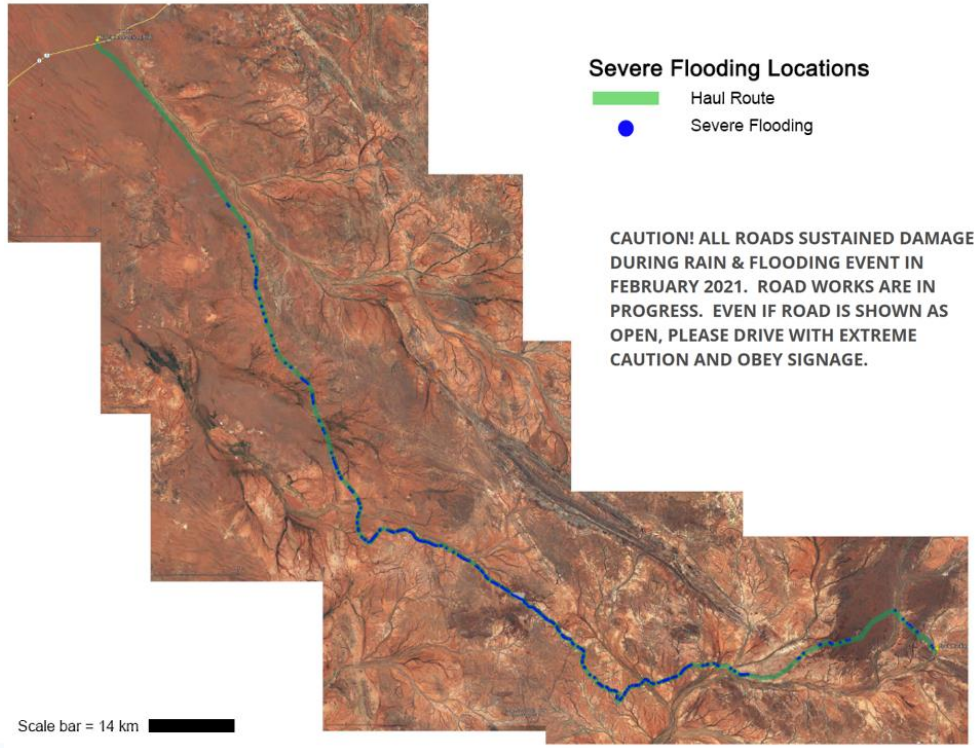
Aim to avoid the ‘boom-and-bust’ cycle

Nature reminding us: Recent observations and impacts

Jan 2020 events in South Australia (5 days)

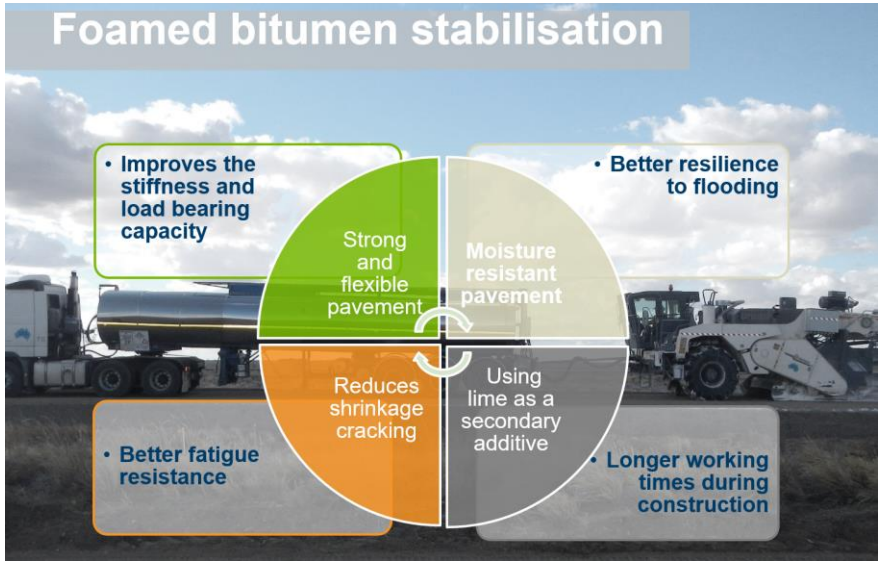


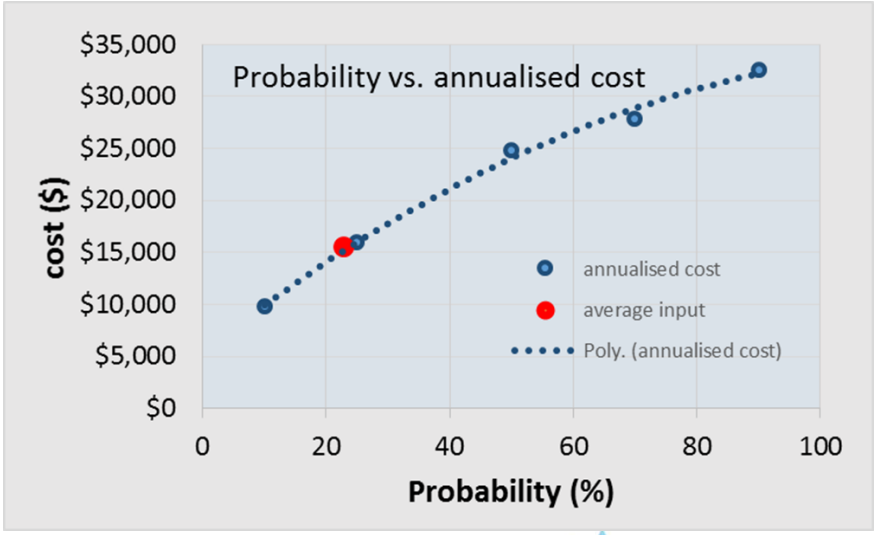
Feb 2021 flooding impacts in the Gascoyne, WA



How can we respond?

- Apply and develop knowledge and technology:
  - Asset management
  - Pavement and materials
  - Network planning and access management
- Appropriate funding
- Delivery and responsiveness
- **As a general rule, all of these plus ‘Sharing with local and international partners’**





Concluding remarks on HDM-4/HDMM

What can we do now (but not always easily)?	What should we do?
1. Identify at-risk locations	1. Focus on low hanging fruit - Document and disseminate cases - Extend functionality (ease of use) and applications guidance
2. Employ comprehensive data strategies	
3. Account for risk through sensitivity / scenario analysis	
4. Investigate recurrence intervals of extreme events (shorter / longer replacement intervals)	2. Research - Updated stocktake of past, recent and ongoing studies - New data and acquisition / risk-based analysis strategies - Re-examine sources / scale of user / social costs and benefits - Define gaps and initiate further studies
5. Vary long term climate indices - only works for gradual deterioration	
6. Account for disruption – diverted traffic, interruptions, slower travel speeds, freight delay, etc.	
7. Always seek key, but missing variables, and calibrate performance	3. Update technical documentation

THANK YOU

The Congress Leaders, Organisers and Support Team

National Assets Centre of Excellence, Austroads and Australian Flexible Pavements Association

Other Collaborators, Clients and Colleagues