

The NSW flooding disaster – what are the adaptation learnings from the 2022 Independent Flood Inquiry?

And some learnings from the 2019-20 Bushfire Inquiry too!

Mary O’Kane

12/10/22

Bushfire learnings

2019-20 bushfires – worst forest fires in the world



AREA BURNED
5.5m ha



LIVES LOST
26



SIMULTANEOUS
EMERGENCY WARNINGS
17



TOTAL FIRE BAN DAYS
59



STATE OF EMERGENCY
DECLARATIONS
3



HOMES DESTROYED
2,476



HOMES SAVED
14,567



INFRASTRUCTURE
LOSSES
\$899m



TELECOMMUNICATION
SITE LOSSES
\$43m



PASTURE DAMAGED
601,858 ha



AGRICULTURAL
BOUNDARY FENCING LOST
88,832km



SHIFTS COMPLETED BY
NSW FIREFIGHTERS
277,415



INTERSTATE AND INTERNATIONAL
PERSONNEL DEPLOYED
OVER 5,600



DOWNLOADS OF
FIRES NEAR ME NSW
2.7m



INQUIRY
SUBMISSIONS
1,967



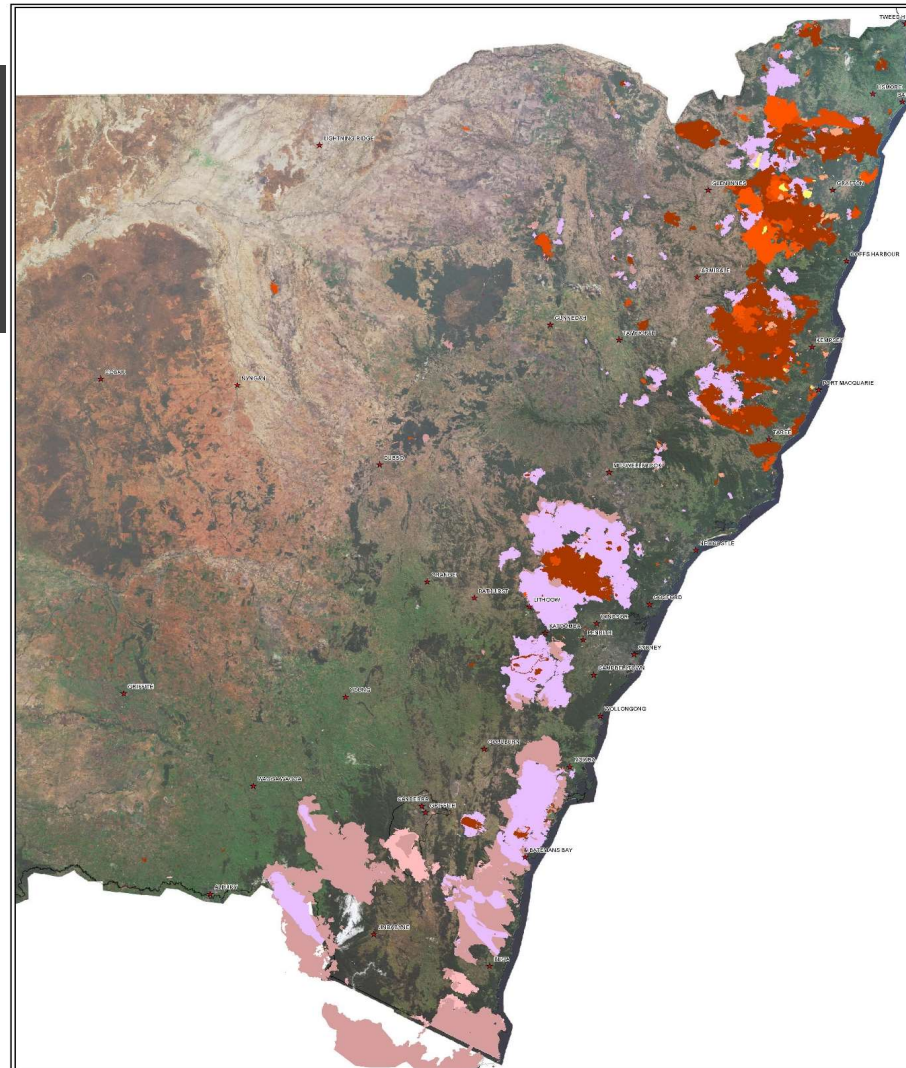
INQUIRY COMMUNITY
MEETINGS
16






FIRE RETARDANT DROPPED
BY LARGE TANKERS
24m litres

What burnt when?

We need to adapt to long fire seasons



	MAP DESCRIPTION Fire Progression July 2019 - March 2020	LEGEND Fire Progression - July Fire Progression - August Fire Progression - September Fire Progression - October Fire Progression - November Fire Progression - December Fire Progression - January Fire Progression - February Fire Progression - March	WARNING INFORMATION 1. This map is not intended to be used as a substitute for professional advice. 2. The map is not intended to be used as a substitute for professional advice. 3. The map is not intended to be used as a substitute for professional advice. 4. The map is not intended to be used as a substitute for professional advice. 5. The map is not intended to be used as a substitute for professional advice. 6. The map is not intended to be used as a substitute for professional advice. 7. The map is not intended to be used as a substitute for professional advice.	KEY MAP 
PRODUCTION INFORMATION Map Details: Base Data: © Spatial Services, SPOT Map Projection: Projected NSW Lambert's Print Date / Time: 24 May 2020 Produced by: Data Management RFS ICT Service No: 184756			SCALE 1:3,000,000	© Department of Finance, n, Services & Innovation 2019

Area burnt & lives lost in recent bushfires

Year	Hectares burnt	Homes destroyed	Lives lost
1993-94	800,000	225	4
2001-02	744,000	135	0
2002-03	1,500,000	112	0
2012-13	1,400,000	62	0
2013-14	574,557	227	2
2017-18	260,000	74	0
2018-19	288,000	37	0
2019-20	5,520,000	2,476	26

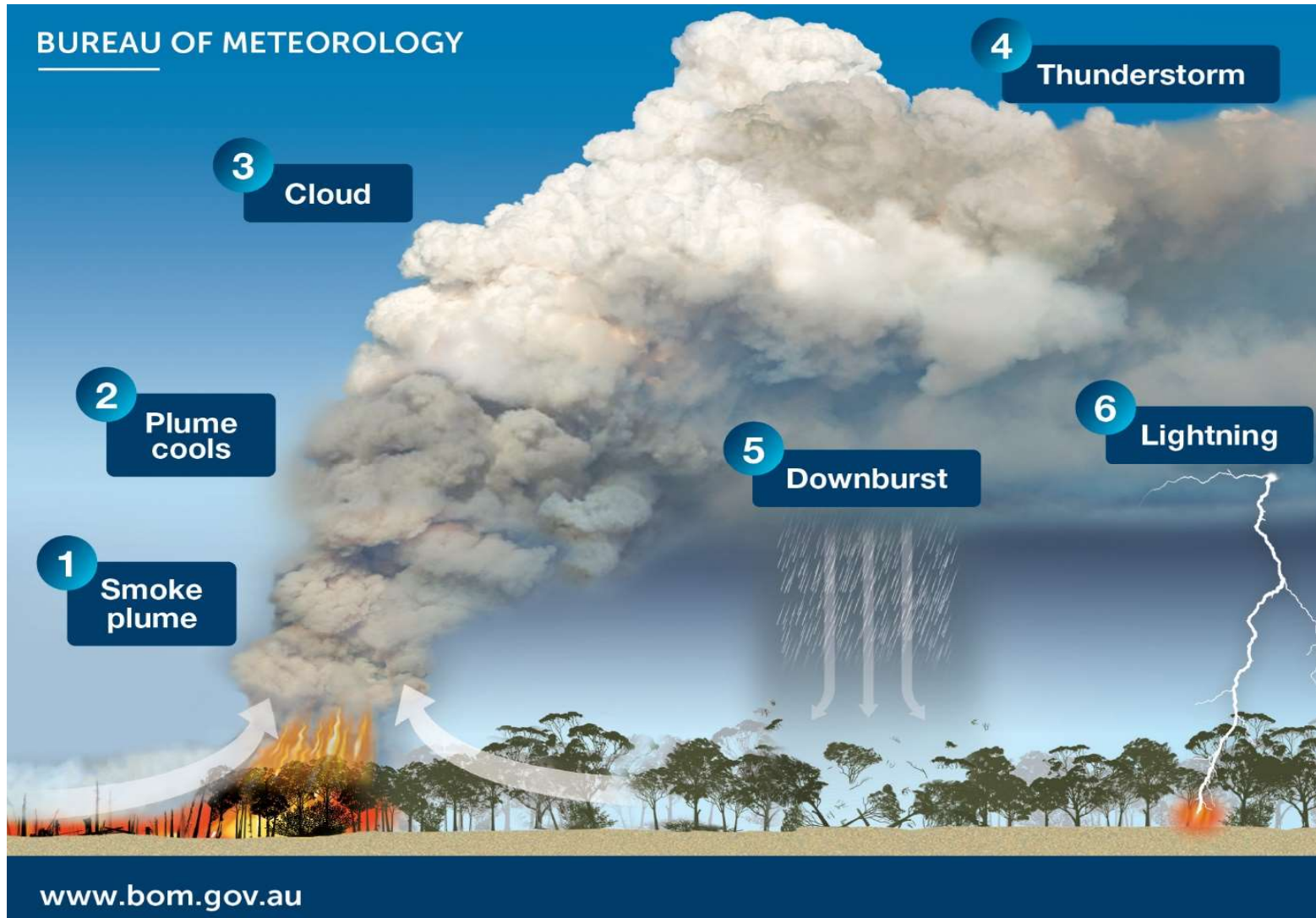
What were these fires like?

- many extreme fires too with a large number of fire-generated thunderstorms (blow up events)
- often described as living things. They take runs, put out a finger, stooge around, race through, creep about, wake up, pop their heads up – and are commonly described as living and breathing
- fires spreading much more quickly than expected during the night, when typically expect that fires would self-extinguish or burn at lower intensity
- ease of new ignitions by lightning and embers
- fires spreading in all directions at the same time, or advancing into the wind
- fires running straight through recently hazard-reduced areas, areas that had been burnt earlier in the season, across mown grass, sheets of water, or even bare soil with no grass
- fires making a scary, roaring noise
- embers spotting far ahead of the fire front to start new fires (e.g. the Clear Range fire spotted up to 7.4 km ahead)
- fires spotting over large water bodies or other features that would otherwise have contained a fire

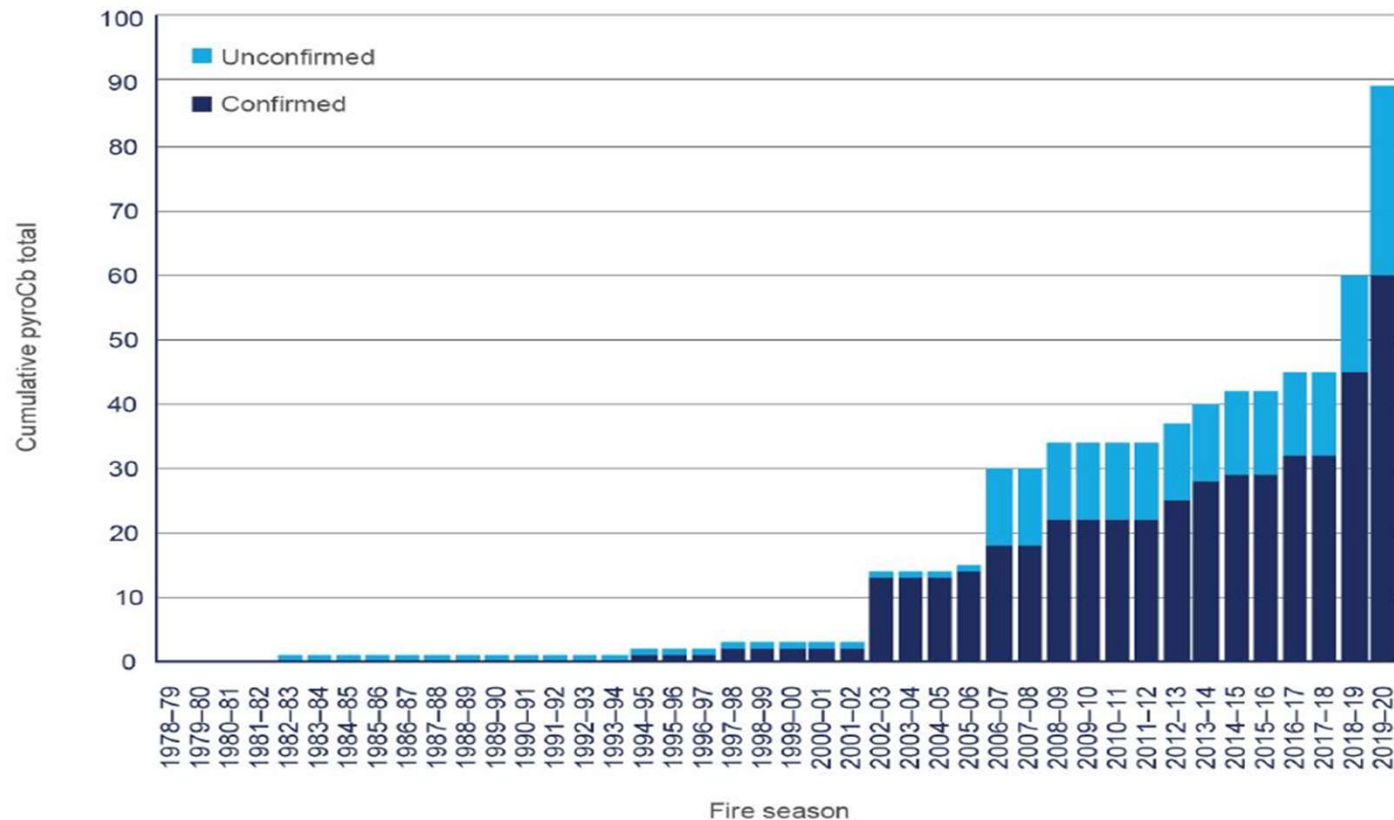
Jason Sharples on Extreme Bushfires

- Extreme bushfires manifest as coupled fire-atmosphere events, and Professor Sharples states that recent research is also revealing the link between blow-up fire behaviour and formation of deep or widespread zones of active flaming which are more likely to produce plumes that reach high into the atmosphere, which are then more likely to involve processes such as cloud formation and heat release which can trigger pyro cumulus or pyrocumulonimbus (fire-generated thunderstorms)
- He states that eruptive fire behaviour, vorticity-driven lateral spread and mass spotting all involve dynamic fire propagation, and all are highly likely to have contributed to escalation of the 2019-20 fires into extreme bushfires
- Föhn wind effects here

Fire-generated thunderstorm



2019-20 bushfires were characterised by a lot of extreme bushfires
Cumulative total of pyroCb events over south-eastern Australia plotted against fire season
(prepared by Professor Jason Sharples).
What will be the reading at the time of next major bushfire season?



Bushfire smoke

- Fine particulate (PM2.5) exposure during the 2019-20 bushfire season was unprecedented. Increased exposure to PM2.5 has been associated with multiple health impacts, which are greater for vulnerable people. Evidence shows that sustained exposure (weeks and months) to poor air quality compared to acute exposure (days) produces greater impact. However, the long-term impacts of prolonged exposure to severe bushfire smoke as seen in the 2019-20 season are unknown.
- Given the expected increases in frequency and severity of major bushfires, smoke is one of many effects of fire that could intensify in future seasons. The associated health risks and financial implications as a result of exposure to bushfire smoke must be better balanced, and become essential components of future fire management. This includes investment in public health research and smoke forecasting/modelling, and improved evidence-based public health messaging.
- Expert: Associate Professor Fay Johnston, UTas

Comments on the Recommendations

- 76 recommendations
- Themes
 - **Annual statement** preparing everyone for what is coming
 - **Education** – public, volunteers, those in risk areas, ...
 - **Accurate warnings** (including Fires Near Me) & consistency nationally
 - Need for **further research** on all aspects of extreme (blow up) fires & how we prepare for both ordinary seasons & phenomena such as fire-generated thunderstorms – become the world experts
 - Need to understand better the impact of **bushfire smoke** especially for those whose underlying conditions make them vulnerable
 - **Develop technology** especially spatial technologies & automated firefighting – become the world experts

Recommendation themes (continued)

- Being ready for extreme fires and fire weather
- Attack fires early
- Improve night firefighting capability
- Being prepared through good administrative systems
- Help be prepared through hazard reduction; protection zones; being good neighbours; checking hazard reduction
- Know where things are, prepare as well as possible, but don't assume protective measures will work
- Support indigenous land management practices

Recommendation themes (continued)

- **Attend to infrastructure** – roads, fire trails, power & telecommunications. Have backup systems
- **There are some places that are dangerous to live**
- Moving to fire-resilient communities
- Know our ecosystems better
- Better gear for firefighting & firefighters
- Recognise & support mental health impacts of bushfires
- **Evacuation arrangements**
- **First responder safety** – make sure firefighters are not exposed to fire-generated weather

The big adaptation messages out of the bushfires

- They are worst forest fires in recorded history
- They are big bad fires and they're coming again. We need to be careful where we live
- 'Get out!'
- Need to be a lot cleverer with technologies and what we've got
- Horrible tragedy is also an economic and social opportunity for the state – we've had the worst forest fires ever; we need to become the best in the world at dealing with them.

It doesn't just happen here!!



Global trends towards more serious fires

- *Europe*
- 250 sq km burnt in forest fires in **Sweden** in 2018
- **more European countries** were affected by large wildfires in 2018 than ever before
- **Portugal** had its first documented fire-generated thunderstorm in 2017 (62 people killed)
- 102 people were killed by wildfires in **Greece** during the 2018 European heatwave
- **Spain** had its largest wildfires in 20 years during the 2019 European heatwave
- **Poland** in April 2020 saw some of the worst fires for over 100 years
- *Asia*
- 2020 fires and heatwaves in **Siberia** including fire-generated thunderstorms north of the Arctic circle
- *America*
- in 2017 central **Chile** experienced “some of the most intense landscape fires on Earth in this century”
- **Greenland** experienced large wildfires in 2017 and 2019
- USA – think **California**

Technology for warning, fighting, locating, preventing

- Based on Australia's strengths in big robotics, sensing, data, data fusion, communications & deep knowledge of how disasters unfold
- Remote sensing from satellites, planes, towers, crowd sourcing (picking early warning signs, spot fires, flood & fire evolution, gathering pre-flood & fire information)
- Apps – must be accurate
- Robots that put out spot fires; walk through floods, bushfires & earthquake zones; fly over floods and fires
- A commercial proposition for a global market

Technology for knowing where things might happen

- *Vorticity-driven lateral spread (VLS) involves rapid lateral fire propagation across the tops of steep, leeward-facing slopes (Sharples et al. 2012, Simpson et al. 2013, 2016), which has the effect of widening the lateral expanse of the fire. In addition to this, the highly turbulent nature of VLS means that ember production is enhanced, and often results in mass spotting downwind of the lateral spread zone. The dense spot fires so formed then interact, coalesce, and form deep flaming zones.*
- *Dynamic modes of fire propagation like eruptive fire behaviour and VLS are subject to specific environmental thresholds such as sufficiently strong winds and sufficiently steep terrain. This means that rugged terrain; that is, areas with local topographic relief >300m, is particularly prone to dynamic fire behaviour. This is consistent with recent research findings that **extreme bushfires occur almost exclusively in rugged, forested terrain** (Di Virgilio et al. 2019), and is also consistent with the spatial patterns of the most damaging of the 2019/20 bushfires, which exhibited a high correlation with rugged terrain.*

The challenge: find these ridges across all Australia
(AI problem)

Flood learnings

January- July 2022 floods: Key Statistics



Over 2,000 km
Roads damaged



> \$500 million
Total agricultural losses

\$2.7 billion
Total infrastructure damage



7,731
People in emergency accommodation



14,637
Homes damaged



212,000
Tonnes of waste (Feb-Mar)

5,303
Homes uninhabitable

Rainfall

- In the north-east of NSW, the last week of February 2022 was the wettest week since **1900**.
- In the Hawkesbury-Nepean, 1-9 March 2022 was the catchment's wettest 9-day period since **1900**.



141,679

Customer support calls to Service NSW



97

NSW Government evacuation centres opened



8,400

Personnel deployed (SES, RFS, ADF and others)



Nearly \$4 billion

NSW and Commonwealth government support provided



LGAs disaster declared:

61 (Feb-May)

37 (July)



9 Lives lost

Recommendation themes *(climate adaptation related ones in bold)*

Emergency Management Arrangements



- [3] Permanent State Emergency Operations Controller
- [5] Resilience NSW and recovery
- [11] Task Force Hawk
- [12] SES and RFS back-office merger

Emergency Management Operations



- [4] Flood rescue capability
- [6] The Community First Responders Program**
- [7] Public Information Functional Area Coordinator (PIFAC) function
- [9] Impact on essential services**
- [10] Transition initiatives

Technology, Research & Innovation



- [1] Knowledge resources to support flood mgt**
- [2] Climate & weather research**
- [8] NSW disaster app**
- [13] Compound mental health studies**
- [14] Flood education**

Reconstruction, Recovery & Housing



- [15] NSW Reconstruction Authority**
- [16] Cost benefit framework**
- [22] Relocating communities most at risk with good homes and amenities**
- [23] Housing and development funding options**
- [24] Housing, especially social housing**
- [25] Caravan parks and manufactured home estates**

Infrastructure, Planning & Land Use



- [17] Landholders can access information on previous disasters**
- [18] Risk-based approach to calculating flood planning level**
- [19] Disaster adaptation plans for all towns**
- [20] Floodplains as assets**
- [21] Simplify the planning system disaster provisions**
- [26] Roads**
- [27] Environment**
- [28] Essential services and floodplain infrastructure**

Causation – *knowing who/what/where will be affected and how badly?*

- For **high-likelihood disaster locations**, we need to know what levels and locations of a particular cause (earthquake, cyclone, flood, bushfire, tsunami) will **result in what impacts** on populations, towns & areas under a wide range of scenarios, estimating worst case, mid-level case etc. And then we need to use this for emergency services & community & government about likely scenarios when cause is estimated
- We need to understand **secondary disasters** (e.g. landslips, water contamination); what triggers them at what locations & timing
- We need to understand '**hidden impacts**' (e.g. smoke inhalation; mental health; mould for those vulnerable). What's the trajectory in time & how many & who are affected?

Causation with climate change/extremes

How might disasters change as the climate becomes more extreme?

First

- explore recent 'extreme effects' & their implications (e.g. **intense, stationary rain leading to bigger floods & more flash flooding** or **extreme bushfires and the impact of pyro-convective storms**)

Then

- consider how climate systems might evolve and what happens when weather events happen within these more extreme climate effects. What sort of disasters might they cause and where? (*high level computation; prediction & imagination*)

**Adaptation innovations can seem
relatively simple
...but have a big effect**

Intense stationary rainfall can lead to higher impact flash flooding



Blue Poles, New York

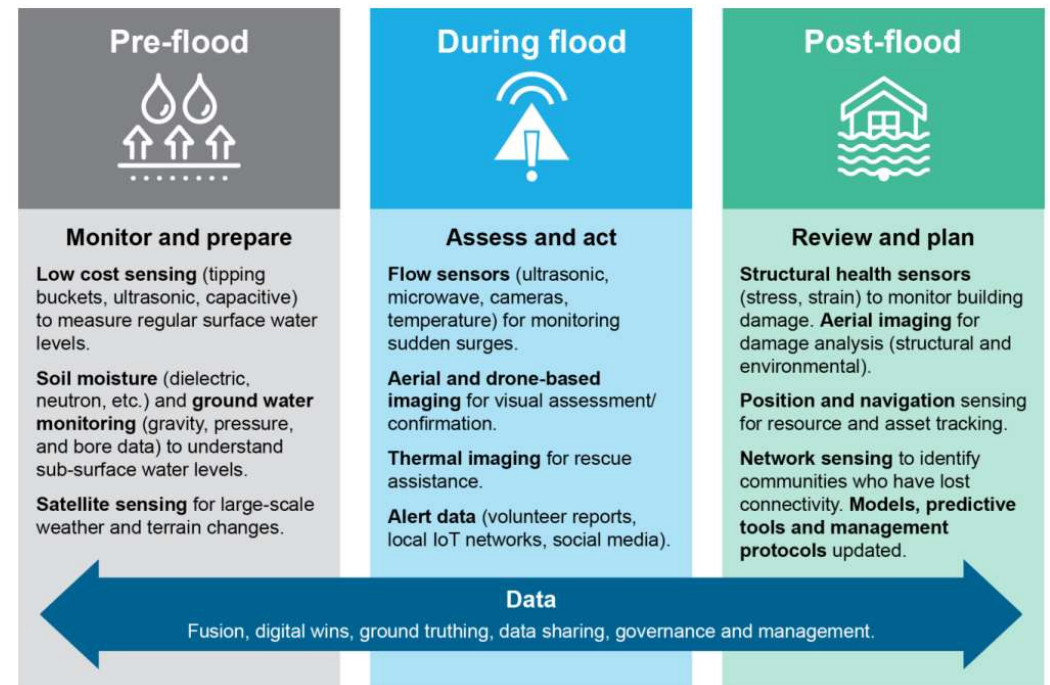
from Joshua Chaffin, Financial Times 29/10/22



[2] Climate and weather research

To enable effective mitigation and adaptation measures in response to changing climate risks, Government establish NSW as a world centre of disaster research and technology development. This should include:

- enhancing climate and weather research capability in NSW through establishing a long-term research funding network/partnership
- commissioning further research and technology development to understand the weather patterns conducive to extreme rainfall with a view to increasing rainfall forecasting accuracy in time and location
- establishing a new State Research Network, NSW Climate Extremes Network, to extend the work of the ARC Centre of Excellence for Climate Extremes so the State has a go-to place for cutting-edge climate science when the Centre of Excellence finishes.



The use of remote sensing technology and data fusion techniques, pre-during and post flood. Source: NSW Smart Sensing Network.

Public policy & administrative structures (public administration, economics)

- **Disasters as expected?** How maximise prevention of harm & rapid & effective response? What government & administrative structures work best and at what government levels? Measuring quality of response to disaster for learning for next time.
- **Training for governments and the public service**
- **Reconstruction authorities.** How autonomous? Mixing empowerment for rapid response with accountability
- **Disaster response agencies.** How structured? How maximise interaction? Role of volunteers? Rewards & training
- **Decision making capabilities of volunteers**
- **Public education & warning** – what works best for whom? Should it be uniform across the population?
- **Funding. Cost-benefit analysis.** Permanent contingent, draw-down funding?
- **Determining acceptable risk** & communicating that.



Flood Damage. Source: Australian Army Twitter

[15] NSW Reconstruction Authority

Government establish a permanent state-wide agency, the NSW Reconstruction Authority (NSWRA) dedicated to disaster recovery, reconstruction and preparedness.

- source and acquit reconstruction funding from state, Australian Government and philanthropic sources
- ensure disaster relief grants schemes are put into place quickly and ensure rapid and effective distribution of disaster relief grants
- be the clear lead agency responsible for managing and coordinating Government's program of housing and infrastructure renewal and recovery within disaster-affected communities
- ensure there is appropriate project management, monitoring, evaluation and reporting of recovery implementation and associated civil engineering and public works at both a state and local level

As the state's lead agency responsible for disaster prevention, the NSWRA would work collaboratively with key stakeholders to improve risk reduction and disaster adaptation. In particular, it should work with disaster-prone communities, local government and agencies across state government to develop a State Disaster Mitigation Plan.

Further, it is recommended that the NSW Reconstruction Authority be established and function under dedicated legislation [the NSW Disaster Reconstruction Act] that is modelled on the Queensland Reconstruction Authority Act.





[3] Permanent State Emergency Operations Controller (SEOCN)

That, to improve NSW's ability to prepare and respond to floods and other disasters, Government establish a new Deputy Commissioner of NSW Police Force to take on permanently the SEOCN role. This role, in addition to current SEOCN functions, would be responsible for:

- chairing the State Emergency Management Committee
- facilitating collaborative risk management and compliance activities
- improving operational readiness and preparedness for emergencies, including training, education, and pre-deployment of assets
- ownership of a state capability framework to ensure combat agencies can resource a catastrophic event
- leading training standards across combat agencies, local government, NGOs and essential service providers.
- establishing funded permanent emergency management police positions
- State Emergency Recovery Controller responsibilities



NSW Police and Army Personnel during 1954 Northern NSW Floods. Source: NSW State Library.



Flood Inundation in Lismore. Source: NSW Spatial Services

[5] Resilience NSW and recovery

That, in order to enhance NSW disaster preparedness, response and recovery, and meet the needs of the people of NSW prior to, during and after a disaster, and provide clarity on agency roles and responsibilities, Resilience NSW be reshaped to 'Recovery NSW'. The new agency will be more streamlined and agile to drive recovery in the first 100 days post disaster.

To achieve this, Resilience NSW's functions should be reallocated as follows:

- disaster preparedness and support, and disaster emergency management policy and service delivery to the SEOCON [Recovery NSW]
- community engagement and public education on disaster risk and preparations to DCS/NSWRA
- disaster recovery and renewal management and coordination to the newly created NSWRA
- evacuation centre management and coordination to the Department of Communities and Justice (DCJ), which includes support for self-styled community evacuation centres.
- welfare services functional area (WELFAC) to the DCJ
- grants administration to the Department of Customer Service (DCS)/Service NSW for immediate relief and the NSWRA for longer term recovery and reconstruction.



Source: The New Daily

[6] The Community First Responders Program

Government create a 'Community First Responders Program', funding appropriate community equipment and training, particularly in high-risk catchments along the east coast of NSW.

This program could support and empower community led initiatives such as disaster response, evacuation centres and the provision of services such as psychological first aid.

To plan for volunteerism into the future, the State Emergency Management Committee (SEMC) commission a review of volunteerism in NSW.

To ensure Indigenous communities are included in emergency planning and preparation, emergency management processes:

- develop an Indigenous first responders program working with Aboriginal communities in flood affected regions to understand what is needed, and resourcing this program appropriately, and
- ensure Aboriginal Community Liaison Officers (ACLO) form part of the Local Emergency Management Committees and are present at evacuation centres during a disaster to better serve Indigenous communities.



Education & training (education, psychology, communications, cognitive science)

- **Disaster education in schools** – what works best for highest impact on kids, families & community?
- **Public education & warning** – what works best for whom? Should it be uniform across the population?
- Training for professionals & volunteers
- Intelligent, interactive, online manuals

Medical & veterinary

- How does natural disaster trauma manifest? Mental health issues develop over what timeframe? Who is most at risk? What can be done in treatment/prevention?
- Long-term 'hidden' impacts e.g. smoke, mould
- Animal health effects

Planning and use of affected land (planning, engineering)

- Defining acceptable risk in an era of climate change
- Flood planning level etc.
- Planning instruments/systems including disaster provisions that are clear, coordinated and comprehensive
- Floodplain use (for uses other than housing)
- Resilient housing at low cost
- Roads for safe evacuation and transport



[18] Risk-based approach to calculating flood planning level

That, to take account of greater knowledge of climate change, Government reinforce its adoption of a risk-based approach to calculating the flood planning level for planning purposes and, through the NSWRA, immediately start a process of revising all flood planning level calculations in the state's high-risk catchments.

As well as reviewing the flood planning level, this 5-yearly review should include reviewing any floodplain lease conditions and adjusting them as necessary in the light of better knowledge of climate change impacts.

In working out a tolerable, risk-based flood planning level, consideration should be given to the PMF, 1% AEP, 0.02% AEP, existing development, approved but not yet constructed developments, and existing and approved but not yet constructed evacuation routes.

- extend and then maintain the DPE state-wide flood database and associated visualisation interface. This database should link to LandiQ.
- act as the main coordination point for all NSW hydrological modelling, working with local government, other state agencies, universities, professional to improve future NSW flood risk assessment with the Bureau's meteorological and climatological research and riverine flood models
- support local councils to improve modelling of and ensure adequate and appropriate alarm systems for flash flooding.





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[21] Simplify the planning system disaster provisions

To simplify and improve the state planning processes especially when anticipating and recovering from a disaster, Government:

- ensure there is a clear line of sight directing councils and planning authorities to include disaster response and resilient settlement outcomes in long term strategic plans
- ensure that Ministerial Directions on hazard and natural disasters are updated to reflect the new risk-based approach to flood planning levels and deliver the disaster adaptation plans to the zoning process
- create specific flood planning provisions as a new chapter in the Resilience and Hazards SEPP
- update planning guidance so that wherever possible community facilities, such as might be used for evacuation centres, are located above the probable maximum flood and essential services are located above the flood planning level
- ensure that the strategic land use frameworks and related controls permit new developments only in line with the evacuation capacity both individually and cumulatively



St. George Caravan Park, Lower Portland, 26 March 2021 (2 days after the flood peak). Source: Infrastructure NSW



[22] Relocating communities most at risk with good homes and amenities

To empower vulnerable people and communities to relocate, Government through the NSWRA:

- identify and prioritise those communities most at risk from future disasters, and for whom relocation may be appropriate or necessary
- leverage the work done through Government's homes, cities, manufacturing and skills policies, to collaborate and work with these communities in examining, designing, building and installing affordable, attractive and insurable housing
- utilise best-practice policy for rapid urbanism and community-building to establish new settlements.

This should also include considering how to repurpose floodplains for community use and benefit, i.e. recreation, sports and energy production as part of the process of returning land below the flood planning level to Government ownership. It should also consider the role of locally manufactured, well-designed and regulated modular housing solutions.



Source: Dominique Opdam, submission to the Inquiry.

Ecology

- How will the structure of vertebrate, insect and vegetation communities change in the future as a result of warmer temperatures and more frequent natural disasters?
- How do we adapt? Do we just accept that some valuable ecosystems will be written off (e.g. do we try to establish buffer zones that are relatively fire resistant & flood free, for example around the rainforests in north-east NSW? Or do we try to transplant some of their species uphill or southwards?)
- How do we effectively draw on first nations knowledge?

R&D areas needing attention, highlighted by NSW Bushfire & Flood Inquiries

- Causation
- Technology for warning, fighting, locating, preventing
- Public policy and administrative structures
- Education and training
- Planning & use of affected land
- Ecology

Disaster Science Disciplines – a broad church; are we all speaking the same language?

- Disaster science
- Ecology
- Public administration
- Management
- Cultural studies/anthropology
- Town planning
- Architecture
- Geography
- Engineering
- Computer Science (including Artificial Intelligence & Data Science)
- Psychology
- Education (School Education; Community Education)
- Communications
- Medicine (including Public Health & Psychiatry)
- Economics