

From: [NSW Government](#)
To: [Flood Inquiry](#)
Subject: Floods Inquiry
Date: Wednesday, 8 June 2022 10:03:25 AM
Attachments: [Mitigate or migrate - Submission2.pdf](#)

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Submission details

I am making this submission as	An academic/researcher
Submission type	I am making a personal submission
Your position in the organisation (if applicable)	Professor
Consent to make submission public	I give my consent for this submission to be made public

Share your experience or tell your story

Your story	This is my second submission, prepared after further data analysis, that convinces me that mitigation is likely uneconomic and infeasible.
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I'm concerned that there is no clear message to households and business owners now renovating flood damage, that a relocation will ultimately be offered. CSIRO can confirm later, but leaders should foreshadow and commence planning for relocation.

Terms of Reference (optional)

The Inquiry welcomes submissions that address the particular matters identified in its [Terms of Reference](#)

1.1 Causes and contributing factors

The equivalent of two Sydney Harbours fell in the Lismore catchment, causing river flows as fast as an olympic swimming pool per second (average across the water body, faster in the middle). Existing mitigation structures were overtopped (or made little difference), and arguably made some damage worse.

1.5 Recovery from floods

Some prominent individuals advocate for mitigation, even though this seems unlikely - and this makes wise investment decisions by households and businesses difficult. Fourteen weeks after the flood, people cannot be sure if renovations should be designed to last months or years, because of uncertainty about relocation. The CSIRO study with no agreed deadline is unhelpful - investors need a 'best guess' now.

Supporting documents or images

Attach files

- [Mitigate or migrate - Submission2.pdf](#)
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When the obvious response to a flood is too hard to face...

Key point: *Authorities urgently need to indicate to the community that the likely solution to the floods is to relocate vulnerable infrastructure, because mitigation is not feasible. This will enable investors to make rational decisions about renovation investments, and avoid wasted resources and effort. Fourteen weeks after the flood, some prominent individuals continue to make unsupported statements promoting mitigation and encouraging poor investment decisions, in spite of sufficient evidence to the contrary. CSIRO can offer a more precise and detailed report later, but the flooded community urgently needs some informed leadership.*

Much has been written about denialism¹, and it is often attributed to bad intent, but sometimes the truth is simply too hard to face, and it is more comforting to deny what is in plain sight. The philosopher Roger Bacon proposed that the way forward is not merely finding correct answers, but rather to find the best questions that enable us to dismiss the unreliable and find the truth, and thus reject views that are merely what people want to hear². Hence this is an attempt to pose some good questions, and offer some evidence that may help inform decisions arising from recent floods Lismore.

Lismore has faced 100 floods over 6m in its 152-year history³, with three of its five biggest floods within the last five years. The flood of 28 February 2022 was two metres higher than the supposed “1-in-a-100-year” event and 2.3m higher any previously recorded flood. So how should the community respond?

Lismore owes its location, on the Wilsons River at the confluence with Leicester Creek, because this was the head of navigation, and shipping was the major form of transport. But its reliance on shipping ended in 1954 when the North Coast Steam Navigation Company went into liquidation⁴. Since then, Lismore has relied on rail and road transport, and has gradually changed from a river-centric to a road-centric town. This transformation was completed with the construction of a levee in 2005 which conceals and isolates the river from most of its citizens. So why do the CBD, and residential areas remain vulnerable on the floodplain? The need for action has been articulated many times, but there is little evidence of progress, despite concerns expressed 75 years ago...

After a series of floods in the 1940s, the Richmond River Interdepartmental Committee (RRIDC) advocated minor levees, drains and diversion channels, resulting in the South Lismore levee in 1960⁵. The 1954 flood led to a voluntary acquisition program. The 1974 flood prompted government funding for the new Goonellebah commercial centre⁶. The 1980 Lismore Floodplain Management Study examined 13 mitigation proposals and concluded that none were economic and some were ineffective or deleterious. The 1982 RRIDC report reaffirmed that structural works would offer only minor benefits and would not be cost-effective, and advocated buy-backs, land swaps and relocation assistance. Mitigation structures were investigated again after the 1989 flood, and it is an indication of inaction that long-term Lismore residents have recently expressed frustration in a Council-led community meeting “*Why are we still asking the same questions, and showing the same lack of*

¹ <https://theconversation.com/dont-look-up-hollywoods-primer-on-climate-denial-illustrates-5-myths-that-fuel-rejection-of-science-174266>

² <https://theconversation.com/the-first-scientists-800-year-old-tonic-for-what-ails-us-the-truth-131366>

³ <https://lismore.nsw.gov.au/files/2022-033-2022-.pdf>

⁴ <https://www.abc.net.au/news/2017-09-27/curious-north-coast-wilsons-river/8979708>

⁵ <https://www.lismore.nsw.gov.au/page.asp?f=RES-NBE-03-87-68>

⁶ <https://lismore.nsw.gov.au/a-short-history-of-flooding-in-lismore>

action, as we did 30 years ago?". In 2005 a \$19 million levee, designed to protect against a 1-in-10 flood, was constructed, just in time to protect Lismore from another flood⁷. After the 2017 flood overtopped the levee, a further \$8 million was spent on mitigation⁸. And the most recent floods of February and March 2022 prompted the Federal Government to announce a \$10 million flood mitigation study, and the local member to declare⁹ "the debate is over – we will be doing engineering work for flood mitigation". This seems like a scene from Groundhog Day!

Meanwhile the flooded community concentrates on the clean up and tries to engage with a series of government inquiries - but the danger in this lack of urgent planning for the future is death by attrition as businesses leave the Lismore CDB and relocate to other regional centres less prone to flooding.

Public meetings are not necessarily representative of the community as a whole¹⁰, but such meetings seem to be rather evenly divided on the question of whether to mitigate future floods, or to migrate vulnerable infrastructure away from the floodplain. Proponents often advocate strongly and passionately for their position, but reliable evidence to support their case is not always evident. The decision to mitigate or migrate is a big one, so it is critical to share the evidence and discuss the implications to fully inform all the diverse views presented, and to help establish the feasibility and implications of all options. It is rather easy to imagine and resist the upheaval of migrating to higher land, so the promise of an engineered safety net (levees, etc) is attractive, perhaps irresistible, even if the evidence is thin. That's why it is particularly important to investigate (once again) the credentials of these proposals...

The recent record-breaking flood occurred after a major rainfall event during the night of 27-28 February. WaterNSW¹¹ maintains four stream gauges that sample about half the catchment upstream of Lismore. These four gauges recorded a flow of about 400 Gigalitres during the rainfall event, an amount equivalent to about 80% of the volume of Sydney Harbour. But some tributaries are not sampled by these gauges, so supplementary data are needed to understand the complete scenario. The catchment upstream of Lismore has a total area of 1,390 km², and is sampled with 14 BoM rain gauges within or near the catchment. The median rainfall in these gauges, coupled with the catchment area, suggests that 1011 Gl (about 2 Sydney Harbours) fell in the catchment during the rainfall event¹². Streamflow calculations indicate that at its peak, the Wilsons River at Lismore flowed at 200 Gl/day (about an Olympic pool per *second*), consistent with a 1000 Gl rainfall event. That is an unprecedented volume, difficult to mitigate – but it should not be dismissed as an aberration, as it is comparable to one recorded in oral history that inundated Cathedral Hill¹³. So how would the proposed mitigation initiatives perform under this scenario?

There have been suggestions¹⁴ that the proposed Dunoon Dam could help mitigate floods – but the catchment of the proposed dam is only 5% of the catchment upstream of Lismore, and its planned

⁷ <https://www.abc.net.au/news/2005-06-30/lismore-residents-evacuated-ahead-of-flood-peak/2048020>

⁸ <https://www.echo.net.au/2019/09/lismores-8-2-million-flood-mitigation-project/>

⁹ <https://lismoreapp.com.au/news-sport/news/the-flood-mitigation-debate-is-over-government-throws-big-bucks-at-solutions?id=6233f52178b39605c54aaca9> – but the terms of reference and completion date have not been revealed.

¹⁰ Those most affected by the flood may be too busy with their recovery to attend...

¹¹ <https://realtimedata.watarnsw.com.au/>

¹² 27/2/22 to 1/3/22, with 70% of the rain falling during the 24 hours to 9am 28 February

¹³ <https://www.abc.net.au/7.30/lismore-surveys-the-devastation-and-loss/13778842>

¹⁴ There is an eloquent argument for this dam and other mitigation structures here

<https://naturaldisaster.royalcommission.gov.au/system/files/submission/NND.001.00004.pdf> and

capacity is only 50 Gl, just 5% of the mitigation needed. So to achieve any meaningful mitigation, we'd need a dozen such dams, scattered across the various tributaries, and we'd need to keep them empty, ready for unexpected rainfall events – it is doubtful that this could be justified, economically, ecologically, or culturally¹⁵. Detention basins smaller than this proposed dam are even less likely to assist with rainfall events of this magnitude.

Other proposals require some hydrology¹⁶ but the essence is that four things determine water flow in a river:

1. Cross-sectional area (a large channel carries more water than a small one);
2. Wetted perimeter (less contact with the sides and bottom allows water to flow faster, so a semi-circular channel will flow faster than a wide shallow or narrow deep channel);
3. Roughness (water flows faster on smooth concrete than in channels with natural vegetation, and thicker vegetation means slower flow);
4. Slope (water flows faster on steeper slopes).

Because Lismore is almost at sea-level (and the river at Lismore is tidal) little can be done to change the slope, but the other components can be manipulated. Engineering structures (levee, canals, etc) can change the cross-sectional area and the wetted perimeter, but success with these interventions depends on assumptions and circumstances, and they are prone to sudden failures (levees overtop¹⁷ if flows exceed specifications). In contrast, the roughness of a watercourse is easily modified (eg, by planting trees to slow flows, and maintaining short grass to increase flows), and such interventions are not subject to sudden failure, and are tolerant of extreme situations.

Raising a levee is problematic because it restricts the spread of water (reducing the cross-sectional area), and thus causes the water constrained by the levee to rise to greater heights than in an unconstrained channel. In a wide floodplain where a comparatively small proportion of the land is protected with a levee, this effect may be imperceptible, but in a constrained floodplain (like the Wilsons at Lismore), the effect on river height will be significant. For example, the Wilson River narrows slightly below the CBD, forming a choke point that influences flood behaviour - the additional constriction that would be created by raising the existing levee (to say 15m) would reduce the flow of a 14.4m flood to 25% of what it recently was, and would thus cause water to back up, and ultimately to overflow the higher levee (even if a levee reached 20m AHD it would not contain the water in the February flood, and would merely delay and divert the water elsewhere). Levees can be effective on wide floodplains, but they are unlikely to be successful in Lismore because of its difficult topography.

Other engineered interventions are equally impractical. A canal would need to be very wide and deep to provide a meaningful reduction in stream height. The difference in water flow between the existing levee height and a 14.4m flood is about 20-fold, so a mitigation attempt is a major challenge

here <https://www.youtube.com/watch?v=qZ-faMGAvqA> – but sadly, they fail to appreciate the volumes of water involved.

¹⁵ <https://issuu.com/jwtpublishing/docs/ainsworth-heritage-preliminary-cultural-heritage-i>

¹⁶ Manning's equation enables velocity and conveyance (volume/hr) of water to be calculated:

$$\text{Velocity} = (\text{cross section/wetted perimeter})^{2/3} (\text{slope})^{0.5} / n$$

where n is Manning's coefficient of roughness and can range from 0.01 for smooth concrete, 0.03 for floodplains covered with pasture, to 0.15 for floodplains covered with trees.

¹⁷ Engineers repeatedly remind me that an overtopping is not a failure of the levee, and are not swayed by my view that it is a failure of the objective to protect against floods – a typical engineer would counter that the objective was to protect against a 10.6m flood, and an overtopping was a failure in setting the objective, not a failure of the structure.

– to divert sufficient water to keep the February flood below 10.4m would require a concrete channel 10m deep and 250m wide! Such an approach seems impractical, expensive and socially and ecologically undesirable. Similarly, it may be technically possible to dredge, widen, straighten and concrete the existing river bed to speed the flow of water through and away from Lismore, but this would be of theoretical interest only as it would have huge social, environmental and economic impacts.

So are there any viable solutions? Raising buildings above flood height is a major undertaking (especially in the CBD), and would substantially alter the character of the city. Renovating buildings to make them flood tolerant (washable, etc) may be possible, but does not deal with the substantial costs of flood disruptions and clean-up. Nor does this strategy protect lives in the event of rapid and unexpected flooding. Clean-up and restoration costs may be tolerable if they occur once in a lifetime, but it is likely that floods once considered rare (e.g., “1 in a 100 years”) are now more common than when those guides were devised¹⁸, both because of changes in the atmosphere¹⁹, and because changes to catchments that cause faster runoff from ever-increasing hard surfaces (roofs, roads, horticultural plastic). The reality is that we need to prepare for more frequent, and more severe flooding.

Setting emotion aside, consideration of the bald facts leads to the conclusion that the only logical solution is to withdraw important infrastructure (dwellings, CBD, factories) from the floodplain. In addition, simple changes to the floodplain can make a five-fold difference in water velocities, so a good complementary strategy would be to reforest the floodplains above Lismore (e.g., tree plantations for koala food, nuts, timber, rainforest restoration, etc), and remove obstructions from the floodplain below Lismore (remove unnecessary structures and encourage conversion of vegetation to pasture and short crops). This would slow the entry into, and hasten the departure of floodwaters from the town area, thus reducing (but lengthening) both the flood peak and the destructive water velocity. Importantly, these interventions would be tolerant of imprecise assumptions and extreme situations, and are not prone to sudden failure.

The decision to relocate homes and businesses is a big one – but there is no avoiding a decision, as doing nothing will not bring back the old Lismore – Lismore has changed, and will never be the same again: this is an opportunity to create the Lismore that the people of Lismore collectively, want. Delaying a decision merely creates attrition as businesses and residents drift away and re-establish elsewhere. For many businesses, the priority is to regain a cash flow, so there is a hasty clean-up, a flood sale, and basic renovations to make water-logged premises presentable. These investments are necessary to recover a cash flow, essential in the short term, but can become stranded assets in the event of relocation – so a prompt decision to mitigate or migrate is critical – but no completion date for the CSIRO study has been announced... It is appropriate to re-examine the various options in the light of new technology - but floodplain residents should not be misled into over-investing in repairs, when the likely conclusion is the need to relocate.

Most views expressed about relocating the CBD appear to be based on limited data, without a clear distinction between “Can you afford to relocate?” and “Would you like to relocate, given adequate support?”. Perhaps the first urgent step is to survey all enterprises (businesses and support services, including the arts sector) to establish under what circumstances they would relocate – if a land-swap

¹⁸ A recent study by Engeny in 2020 seems to completely deny the possibility of floods exceeding 13 m (Page 23 of <https://yoursay.lismore.nsw.gov.au/63006/widgets/316247/documents/187410>)

¹⁹ <https://theconversation.com/like-rivers-in-the-sky-the-weather-system-bringing-floods-to-queensland-will-become-more-likely-under-climate-change-176711>

were available; if there was a buy-back; and/or if 60% of the CBD had already committed to such a move. It is important that such a survey is broadly inclusive, as many shops depend on passing trade, such as the wait time while a car is serviced, or while a partner has an appointment. A good strategy cannot be prepared until such a reliable and comprehensive survey is completed, and inclusive of both owner-occupied and tenanted businesses.

Current discussions have been focussed heavily on businesses and vulnerable land within the city limits. Less emphasis has been given to outlying villages and rural residences equally affected by the flood. Culture and the arts have also received little attention, even though they are prominent, and contribute greatly to Lismore's character and economy. Despite the huge contribution the Koori Mail has made to the broader community in the aftermath of the floods²⁰, the concerns of the Koori community appear to have received little attention. A relocated CBD is a unique opportunity to design specifically to put arts and culture at the centre of a new Lismore, so representative organizations should be engaged in the process.

²⁰ <https://www.abc.net.au/news/2022-03-20/koori-mail-offices-recovery-centre-lismore-floods/100921850>