From:	NSW Government
To:	Flood Inquiry
Subject:	Floods Inquiry
Date:	Wednesday, 1 June 2022 6:07:23 PM
Attachments:	Mitigate or migrate.pdf

Your details

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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, Southern Cross University
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	I prepered the attached submission following a public meeting in which there were numerous calls to mitigate floods rather than to relocate

dwellings, and I fear that people advocating flood mitigation do not appreciate the vast volumes of water involved.

Terms of Reference (optional)

The Inquiry welcomes submissions that address the particular matters identified in its Terms of Reference

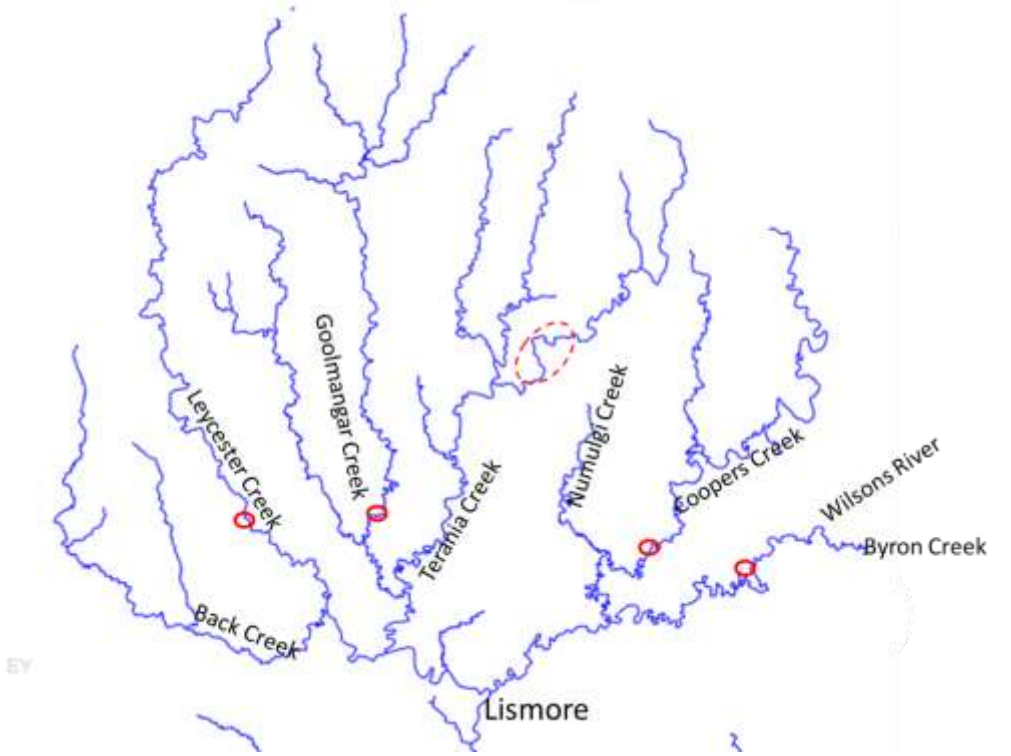
Supporting documents or images

Attach files

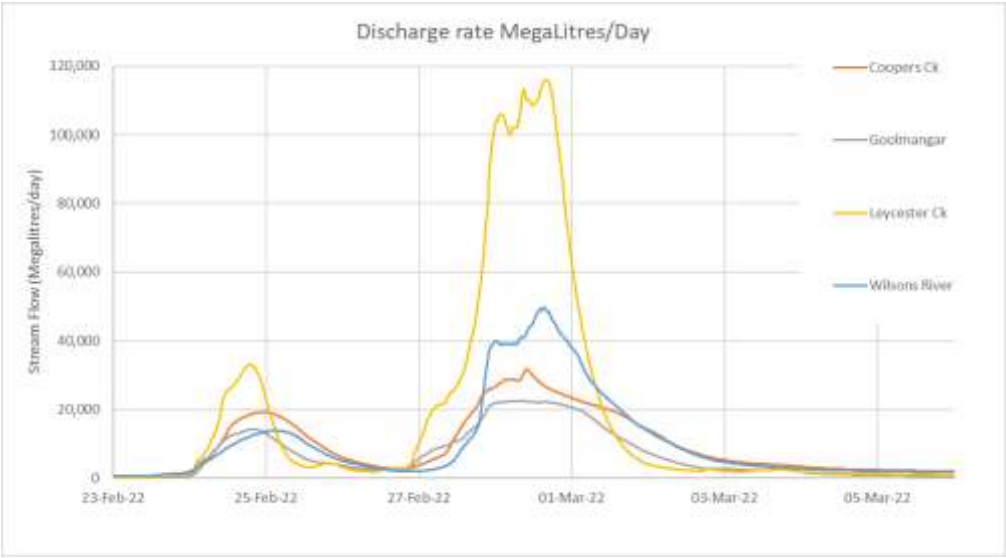
- Mitigate or migrate.pdf

Mitigate or migrate?

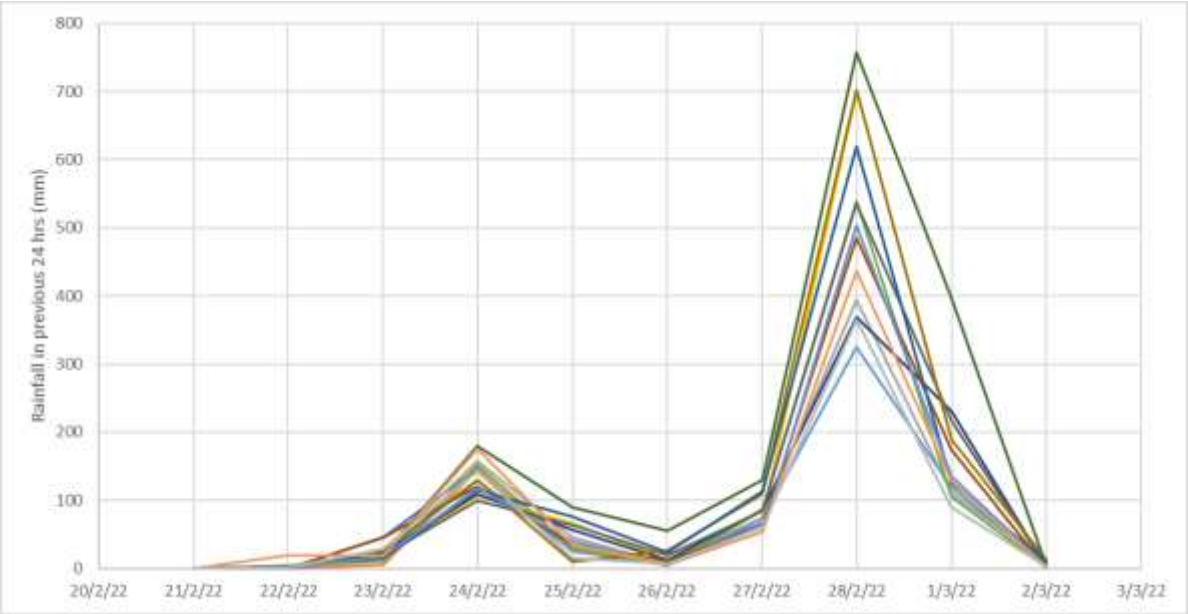
There have been a number of calls to mitigate floods in Lismore with structures such as canals or levees – is this possible, and what would such structures look like?



Firstly, a quick recap of the watercourses involved (above). The red circles indicate WaterNSW stream gauges, and the dashed oval indicates the site and extent of the proposed Dunoon Dam. These four gauges recorded a flow of about 400 GigaLitres during the rainfall event of 28 February, a substantial volume of water (about 80% of the volume of Sydney Harbour)! On that occasion, most of the water arrived via Leycester Creek in the west of the catchment (and so should have showcased the effects of the new engineering works near the airport) – but every flood is different, and it is not uncommon for floods to arrive from the east via Wilsons River.



These WaterNSW gauges sampled only four of the tributaries of the Wilson River catchment upstream of Lismore, leaving large parts of the catchment unsampled. So how much water did reach Lismore in the February flood? The catchment upstream of Lismore has a total area of 1,390 km^2, and is reasonably well sampled with BOM rain gauges, of which 14 provided reliable measurements within (or just outside) the catchment area during the period of interest (late February to early March 2022):



Rainfall prior to 27 February raised water levels enough to trigger a minor flood warning, and many CBD store owners had lifted their stock above the 1974 level during Sunday 27 February, but the heavy rain during the night of 27-28 February (included in rainfall totals 28 February) changed the prognosis. Rainfall during that night varied greatly across the catchment, but it is clear that much of the rainfall fell during the three days 27 Feb to 1 March. These rainfall records (above graph, from 14 locations, ranging from Bentley in the west, Lilian Rock in the north, to Nashua in the east) indicate that the rainfall across the catchment would have amounted to more than 1000 GigaLitres (median 1011 Gl, mean 1057 Gl) during those 3 days – about 2 Sydney Harbours - a challenge to mitigate! Streamflow calculations suggest that at its peak, the Wilsons River at Lismore was flowing at slightly more than 200 Gl/day, consistent with a 1000 Gl rainfall event.

There have been suggestions[1] that the proposed Dunoon Dam could help mitigate floods – but the catchment of the proposed dam (which includes the existing Rocky Creek Dam) is only 5% of the catchment upstream of Lismore, and its planned 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 cross 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 or ecologically.

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

Others have proposed diverse engineering solutions ranging from canals to levees. An informed evaluation of these options requires some maths (namely Manning's equation[2]) but the implication is that a few things are critical to water flow (in order of importance):

1. Cross-sectional area (wide and deep carries more water faster than narrow and shallow)
2. Wetted perimeter (semi-circular channels flow faster than shallow or narrow channels)
3. Roughness (water flows faster on smooth concrete than in channels with natural vegetation)
4. Slope (water flows faster on steeper slopes).

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 wetter perimeter, but success with these interventions depends on assumptions and circumstances, and they are prone to sudden failures (levees overtop 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 across the floodplain (reducing the cross-sectional area), and thus causes the water constrained by the levee to rise to greater heights than otherwise. In a wide floodplain, this effect may be imperceptible, but in a constrained floodplain (like the Wilsons at Lismore), the impact outside the levee will be significant. For example, the Wilson River narrows slightly near John Street (just south of the Ballina Street bridge) forming a choke point that influences flood behaviour - the additional constriction created by a raising the existing levee (to say 15m) would reduce that flow of a 14.4m flood to 25% of what it would otherwise be, causing 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 divert the water elsewhere). Levees can be effective on wide floodplains (such as on the Clarence near Grafton), but they are unlikely to be successful in Lismore because its floodplain is restricted and confined by hills on both sides.

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 at John Street between a 10.4 (the existing levee height) and a 14.4m flood is about 20-fold, so a mitigation attempt is a major challenge – to divert sufficient water to keep the February flood below 10.4m would require a concrete channel 10m deep and 250m wide! – an approach that 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, and would need to stretch from the city limits in the north (Wilsons River) and west (Leycester Creek), to Trevan Road and beyond in the south...

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 cleanup. These 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

[2]Manning's equation enables velocity and conveyance (volume/hr) of water to be calculated:
Velocity = (cross section/wetted perimeter)$^{2/3}$ (slope)$^{0.5}$ / n
where n is Manning's coefficient of roughness and can range from 0.01 for smooth concrete, to 0.03 for floodplains covered with pasture, to 0.15 for floodplains covered with trees.

when these guides were devised[3], both because of changes in the atmosphere, and because changes to catchments that now have faster runoff from ever-increasing hard surfaces (roofs, roads, horticultural plastic).

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 5-fold difference in water velocities, so a good additional strategy would to reforest (e.g., with pecan plantations, koala food plantings, rainforest restoration, etc) the floodplains above Lismore, 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.

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 the opportunity to create the Lismore that the people of Lismore collectively, want.

[3] 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)