Nature-based solutions: Building flood resilience in Lismore Catchment

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Key points

- Richmond Landcare Incorporated is leading a first-of-its-kind pilot project in the northern rivers region in the highly flood-prone Lismore catchment, investigating the role of strategic upper sub-catchment revegetation as a viable Nature-based Solution for reducing downstream flood risk.
- The project directly addresses the legacy of historical land clearing since the mid-1800s, which reduced the contiguous "Big Scrub" rainforest to just 1% and replaced deep-rooted, water-slowing canopies with shallow-rooted pasture grasses that accelerate surface runoff and erosion.
- Unlike traditional river rehabilitation, the location of on-ground works are not just planted along the riparian zone, but strategically designed to target contiguous, neighbouring properties along alluvial floodplains directly upstream of narrow hydraulic pinch points to maximize the cumulative roughness required to slow flood waters.
- To calibrate the project's hydrodynamic model and overcome sparse official data networks, researchers are utilizing instream depth loggers alongside scientifically robust rainfall data collected by local citizen scientists.
- While the specific data is currently undergoing peer review, preliminary modelling results demonstrate that the aggregated impact of strategic upper sub-catchment revegetation delivers a measurable reduction in downstream flood peaks and peak timing.

Abstract

Lismore, NSW is one of Australia's most flood-prone townships, located at the confluence of the Wilsons River and its major tributary, Leycester Creek. The region was subject to extensive historical land clearing, leaving only 1% of the primary ecological community, *Lowland Rainforest in Subtropical Australia* listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Extensive land clearing has exacerbated flooding severity within the catchment. Richmond Landcare Incorporated (RLI) is leading the *Nature-based Solutions: Building Flood Resilience in the Lismore Catchment* (NBS Project), a pilot project that investigates the role of strategic upper sub-catchment revegetation to reduce downstream flood risks by increasing hydraulic roughness and soil infiltration.

RLI identified critical alluvial floodplains and pinch points along the upper sub-catchments of Tuntable and Terania Creeks to focus revegetation efforts and directly engaged landholders to secure 25 contiguous hectares of high-priority riparian zones. The on-ground works approach was co-designed with a Community Advisory Group (CAG), incorporating their decades of riparian restoration expertise to select resilient native "flood champion" species and establish a high-density configuration (1.5m to 2m spacings) optimized for flood attenuation. The project has successfully planted nearly 90,000 trees and sedges.

To overcome critical upstream data gaps, the project integrated a community-driven citizen science rainfall network with Southern Cross University (SCU) to develop a robust hydrodynamic model. Preliminary aggregated results demonstrate that targeted revegetation delays peak arrival times and measurably reduces flood peaks.

Concurrently, RLI partnered with the Widjabul Wia-bal people—the Traditional Owners who recently secured Native Title—to conduct cultural waterway assessments, with the aim to find cultural heritage artefacts in areas that are being revegetated. This collaboration embeds indigenous knowledge of best practice for future river rehabilitation projects, supporting long-term employment on Country.

Concluding in December 2026, this first-of-its-kind pilot establishes a scalable, holistic blueprint for regional climate resilience. It demonstrates that integrating hydrodynamic modelling, proactive community engagement, and Traditional Owner leadership can effectively mitigate catastrophic flooding across the broader Richmond River catchment.

Keywords

Nature-based Solutions, Strategic revegetation, Citizen Science, Traditional Owner knowledge, Community co-design, “flood champion” species

Introduction

Richmond Landcare Incorporated (RLI) is a non-profit, community-led organisation, established in 1998 to support environmental stewardship across the Richmond River catchment. RLI is leading the project *Nature-based Solutions: Building Flood Resilience in the Lismore Catchment* (NBS Project), a pilot study that is collecting evidence to demonstrate how revegetation in upper sub-catchments of the Wilsons River catchment, can reduce flood risk to downstream communities. The project combines undertaking research with Traditional Owners, co-design planting design with the community, while also collaborating with universities to ensure scientifically robust evidence. The NBS Project pilot is first and only of its kind in this flood affected region.

The township of Lismore is the one of the most flood prone towns in Australia with over 150 flood events since recording flood heights began in 1897 (Figure 1). The town is located at the confluence of Wilsons River and its primary tributary, Leycester Creek. The Wilsons River flows from its headwaters on the eastern side of the Nightcap Range meeting with several streams towards Lismore. Its primary tributary, Leycester Creek, drains upper sub-catchments with headwaters in central and western Nightcap ranges. Leycester Creek has historically been the primary contributor to high flood peaks during major flood events in the Wilsons River catchment (Lismore City Council, 2026a). Extreme flooding occurs when the eastern upper sub-catchment streams are also experiencing high rainfall events and flooding flows, as was the case during the catastrophic event on 28 February 2022, where almost all the upper sub-catchment tributaries experienced between 600mm to 1000mm in a 24-hour period (Bureau of Meteorology, 2022) with the flood peak in Lismore reaching 14.4mAHD, two metres above the previous extreme flood record at 12.11mAHD (Lismore City Council, 2026b). One month later, with the catchment still saturated, a second major flood hit the town, with the flood peak reaching 11.4 mAHD (Lismore City Council, 2026b).

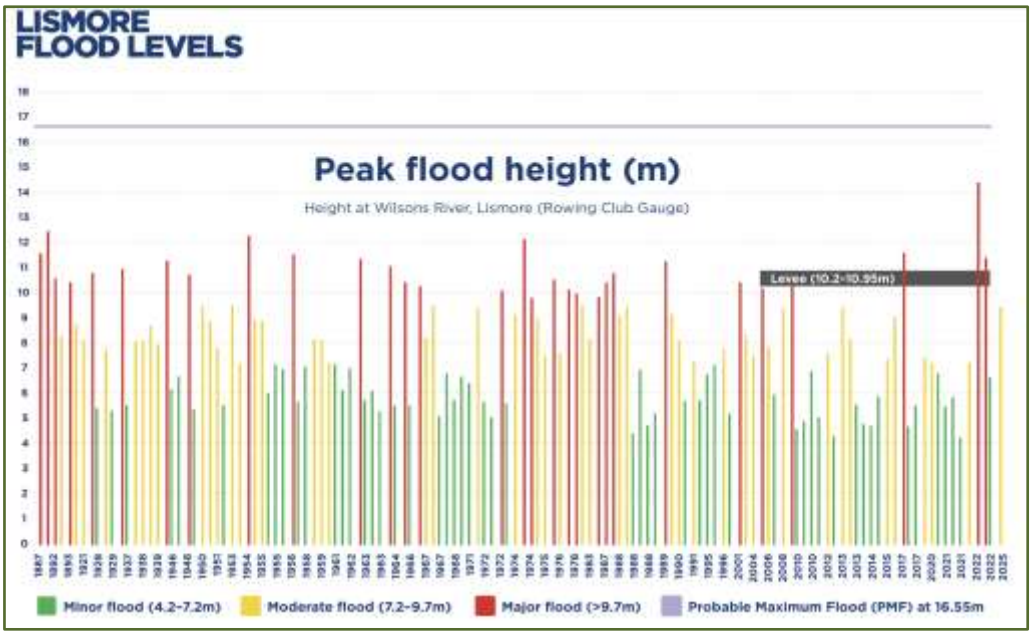

Figure 1 History of Lismore flood heights since 1897. Source, Lismore City Council, 2026

Prior to colonisation, the Wilsons River catchment's primary ecological community was the *Lowland Rainforest of Subtropical Australia*, known as the Big Scrub. It was the largest contiguous tract of sub-tropical rainforest in Australia, covering 75,000 hectares to the east and north of Lismore (Department of the Environment, 2011). Land clearing started in the mid-1800s, with timber harvesting and the establishment of agriculture, where, selectors extensively felled and burned unbroken expanses of bush and trees to the water's edges. Further expansion of agriculture in the early 1900s cleared vast tracts of rainforest for pasture, replacing diverse native canopies with monoculture grasslands and cropping. Only 1% of the original range exists in small, scattered remnants remains and the ecological community is listed as Critically Endangered under the *EPBC Act*.

Research has linked deforestation and agricultural practices to increased flooding severity due to changes in catchment surfaces (Herath et al. 2025). Trees and understorey vegetation on riparian and adjacent alluvial floodplains create physical barriers, termed roughness, that slow down surface flow from the surrounding slopes and overbank flow on upper sub-catchment floodplains and play a crucial role in downstream flood behaviour (Herath et al. 2025; Prinsley et. al, 2025). Further, deep-rooted trees create airspace in soils through transpiration, increasing infiltration during rain events which prolongs the time it takes for surface runoff to occur (Prinsley et al. 2025). The removal of deep-rooted vegetation replaced with shallow rooted pasture grasses has destabilised riverbanks and surrounding hills, leaving the catchment highly prone to massive sediment loss through erosion and landslips (Morand, 2017).

The extensive land clearing that occurred was facilitated by the NSW Government when it passed the *Robertson Land Acts 1861*, which permitted the purchase of Crown land under the legal fiction of *Terra Nullius* (National Museum of Australia, 2022). This legislation significantly accelerated the dispossession of the Widjabul Wia-bal clan of the Bundjalung Nation—the Traditional Owners of the Wilsons River Catchment—severely impacting the community and stripping them of their right to care

The NBS project is responding to the consequences of the previous Government's policy to excessively clear land with strategically placed re-establishment of vegetation on cleared riparian zones, adjacent alluvial floodplains, ephemeral streams and gullies in the upper sub-catchments can slow and capture surface flows, debris, and sediment to reduce flood peak flows, delay peak timing, and improve water quality. The NBS Project represents an opportunity to change how regional flood mitigation is

approached. Reversing over a century of environmental degradation demands a holistic approach to landscape restoration that honours traditional and community knowledge and scientific data.

Methods

Selecting pilot upper sub-catchment streams

Tuntable and Terania creeks were selected for the pilot as they are representative of the upper sub-catchment streams in high rainfall areas of the Wilsons River catchment. They are major contributors of flow volume to the mid-floodplain in the Keerong Valley and to Leycester Creek. The headwaters of both creeks are located within the Nightcap Range, which has the highest average annual rainfall in NSW (NSW National Parks and Wildlife Service, 2025), with average annual rainfall at around 2500 mm per year, or up to 3000 mm per year at higher elevations (Bureau of Meteorology, 2026).

The geomorphology of the upper Terania and Tuntable creeks both comprise steep incised reaches in between areas where the gradient flattens out forming small alluvial floodplains (Morand, 2017). The floodplains are generally the areas that have been cleared and converted to pasture. Tuntable Creek is a first order stream that flows out of the Nightcap Ranges for about 5km where it reaches agricultural land. From here the creek banks have limited native species, with the riparian zone predominantly comprising pasture or woody weeds. The confluence of Tuntable and Terania creeks is in The Channon village (Figure 2). Terania Creek flows from its headwaters through a mix of cleared land and forest for about 10km until it meets Branch Creek, a tributary stream located at the northern boundary of the project area, after which its riparian zone much the same as Tuntable Creek. Downstream of the project area Terania Creek continues to flow through private agricultural land, across the Keerong floodplain where it is joined by multiple tributary streams and gullies to its confluence with Leycester Creek on the Keerong floodplain slightly northwest of Lismore (Figure 2).

Figure 2 The Wilsons River Catchment, showing Wilsons River, Terania Creek, Tuntable Creek and Leycester Creek, and other named streams. Source: RLI

NBS Project –on-ground works project design

As the NBS Project's primary objective is to capture and slow flood waters in upper sub-catchments in the Wilsons River catchment, the approach for undertaking the on-ground works is different from typical river rehabilitation projects and was co-designed with SCU and the CAG. This is both due to site selection approach and the planting design.

Typically, project proponents will run an expression of interest for landholder uptake, with successful applicants being located across the project area and not necessarily connected. For this pilot undertake site selection RLI and SCU used contour maps created in ArcGIS from elevation data extracted from the CSIRO LiDAR digital elevation model flown in 2023. The areas that are best placed for revegetation that will influence the flooding hydrology are the alluvial floodplains upstream of the steep and narrow-incised channels, or pinch points. where flow is constrained and naturally backs up onto the floodplain. Additionally, there are many ephemeral streams or gullies that carry surface flow from the surrounding slopes to the creeks. Figure 3 shows how sites were selected at a s on Tuntable Creek, with the red line at the bottom of the map identifying a pinch point, just downstream of a couple of hectares of floodplain. This process identified around 90 ha within the two pilot streams with floodplains that could flood under moderate to major floods between 50m and 150m from the stream. With the funding available, RLI was able to revegetate 25 hectares.

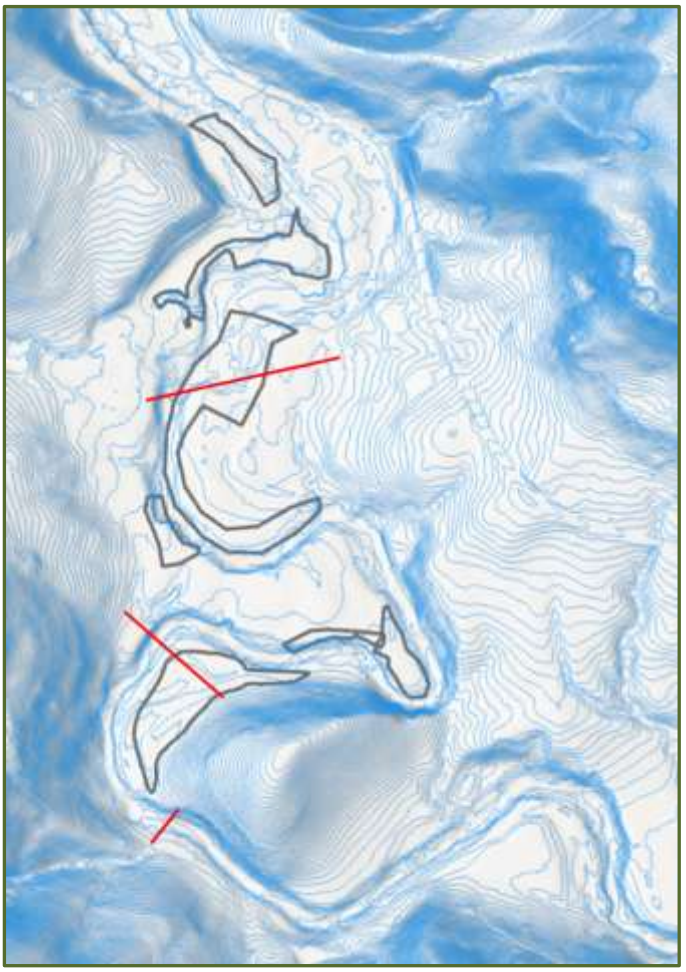

Figure 3 Example of process for using contours to identify sites on low gradient land above narrow channel constrictions as per on-ground works project design criteria. The grey polygons represent the targeted sites

The pilot deliberately focussed on two streams with the aim for revegetation to be able to be aggregated across neighbouring properties where possible. Hydrologically the aggregated cumulative impact of

vegetation across multiple properties along the creek corridor, and on both sides of the creek, will noticeably reduce flood peaks in both height and velocity. By comparison, vegetation established on isolated individual properties scattered throughout the catchment would have little to no measurable effect. This is a critical aspect of the project design. The more connectivity gained, the greater the impact on slowing the flow.

The CAG members advised RLI on which species were best suited to plant in areas that are going to flood, the "flood champions" drawing on their experience through decades of riparian restoration. The flood champions species are those who have survived (and even thrived) major flood events in the upper sub-catchments. It's important to note that many of these species are found in the Lowland Rainforest in Subtropical Australia ecological community.

The CAG also informed the planting density, recommending that trees should be planted around 1.5 metre to 2 metre spacings. This provides a higher roughness coefficient for modelling and will also reach canopy closure sooner, reducing the maintenance burden on the landholder.

On-ground works – implementation

RLI's approach to implementing the on-ground works project is also different from most river rehabilitation projects. Typically, project proponents will run an expression of interest for landholder uptake, with successful applicants being located across the project area and not necessarily connected. Usually, funds are provided to the landholder directly who is then responsible for coordinating the works.

Instead of running an expression of interest process, RLI directly contacted the landholders whose properties we had identified in the site selection process. Most of the landholders were very pleased to be involved. It should be noted that these landholders have inherited the consequences of land clearing, much of which occurred over one hundred and fifty years ago. Many of the landholders we approached expressed that they had been wanting to rehabilitate their creek frontages but had not been able to afford to. Funding through the project covered all on-ground works required including sites prep, revegetation, fencing and off stream watering and some maintenance.

Implementation

As the NBS project is a pilot study, it is critical that RLI has oversight on every aspect of the on-ground works. This is to ensure that it is delivered in line with the planting design specifically created to meet the pilot's primary objective. RLI undertakes regular visits to the NBS sites to meet with landholders and bush regenerators to monitor the sites at various stages of the works including site preparation, planting and maintenance, to make sure the key requirements of the pilot, significantly the survival of the trees in the required plant density, are being met. If substantial tree death occurs, RLI arranges for replanting of those areas to ensure the planting density stays intact.

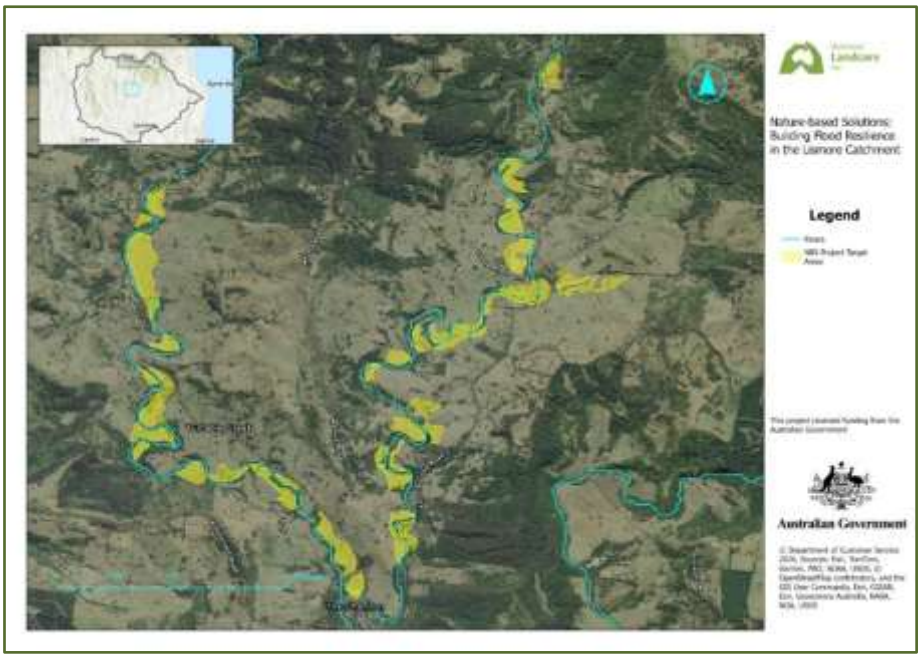

Figure 4 Map of all potential sites in the pilot project area showing the Channon at the bottom

SCU research – hydrodynamic model

RLI engaged SCU to develop a hydrodynamic model to quantify the reduction in flood peak and timing that revegetation in the project area could deliver. The model covers Tuntable Creek and Terania Creek from their headwaters to the bottom of the project area located at The Channon.

The model was calibrated using the following data:

- Water depth was continuously monitored using depth loggers located instream, on the riverbank and on the floodplain flats at several sites. Two loggers had been installed prior to Ex-Tropical Cyclone Alfred and collected data on flood depth over the revegetated areas.
- Cross sections of the creeks to ground truth the CSIRO LiDAR Digital Elevation Model.
- Rainfall - limited BOM gauge coverage failed to warn The Channon during the 2022 floods, spurring a community-ANU citizen science project that now collects upstream rainfall data on Tuntable and Terania creeks. This data, validated during Ex-tropical Alfred, now feeds into SCU's hydrodynamic model.

RLI requested that SCU model the potential sites identified during the site selection mapping process while RLI was securing the landholder agreements required to capture the footprint of those sites. Further, because pilot funding was limited to revegetating 25 ha it was important to model the potential impact that could occur if all the sites that were identified at the site selection stage were revegetated.

Incorporating Traditional Owner Knowledge

The NBS Project objective for engaging with Traditional Owners is to ensure that the NBS Project's final output is culturally informed and includes cultural objectives and outcomes for future Nature-based Solutions projects. RLI has been engaging with the WWGAC board, Widjabul Wia-bal Elders, the Ngulingah Local Aboriginal Land Council and community members of the Widjabul Wia-bal clan.

The Widjabul Wia-bal project is in its early stages and will be delivered through an oversight group that comprises Widjabul Wia-bal Elders. They will provide guidance and direction to the research project, which aims to undertake waterway assessments at three to four sites along Terania Creek, starting in the Nightcap National Park, which is one of the areas included in the Native Title Determination, and then visiting other sites impacted by land clearing. The research will identify cultural values, the threats to those values, inform the development of cultural objectives and outcomes.

Results

The NBS Project started in January 2024 and is due to be completed in December 2026. As such we are still undertaking core activities and collecting evidence, the results of which will be clearer over the coming months.

RLI has achieved the project's revegetation target area of 25 hectares, across 18 properties located on Tuntable and Terania creeks. The project has planted almost 90,000 "flood champion" trees and sedges on riparian zones, adjacent floodplain flats and in gullies with distance from the stream between 50m to 140m. The landholders involved in the project have contributed $176,612 in-kind and cash co-contributions undertaking site preparation and maintenance activities, ensuring an enduring benefit.

While specific quantitative data remains under peer review, the aggregated modelling results from SCU's hydrodynamic model yield crucial qualitative results, demonstrating that strategic revegetation of all upper sub-catchment streams in the Wilsons River catchment, when aggregated, can deliver measurable reduction of flood peaks and peak timing to downstream communities.

The WWGAC have included NBS as an area of interest in their draft Healthy Country Plan. The Traditional Owners are very engaged with the NBS Project and are grateful for the opportunity to get out on Country to undertake the research in culturally significant areas located in the upper sub-catchments to prioritise for future NBS projects. This work will contribute to the final output of the NBS Project and will support WWGAC to develop cultural management plans and proposals for future funding opportunities. This planning will lead to their active involvement in planning and implementing regional NBS projects, leading to stronger cultural outcomes and increased employment on Country.

Discussion

Hydrodynamic modelling and citizen science integration

The development of SCU's hydrodynamic model highlighted calibrating data gaps, specifically the absence of upstream BOM gauges required for accurate early warnings. The "People's Catchment - Terania Citizen Flood Intelligence" project, developed with ANU, successfully bridged this data deficit. The strong correlation of citizen-collected rainfall data during Ex-Tropical Cyclone Alfred validates the robust citizen science in ground-truthing the model parameters.

While specific quantitative outputs are currently undergoing peer review, preliminary results have demonstrated that aggregated, strategic and targeted revegetation of upper sub-catchment riparian zones, adjacent alluvial floodplains and gullies can deliver a measurable reduction in downstream flood peaks and delays peak arrival times.

Strategic geomorphic targeting and engagement models

The NBS Project demonstrates a scalable alternative to traditional, fragmented river rehabilitation programs. Traditional EOI processes typically result in isolated, non-contiguous revegetation parcels that provide benefits at small property scale. In contrast, RLI's proactive model directly targeted contiguous landholders along high-priority, heavily cleared reaches of Tuntable and Terania Creeks, creating opportunities for aggregated cumulative benefits, which are directly transferable to other upper sub-catchment streams in the Wilsons River catchment.

Traditional Owner waterway management

Catchment rehabilitation cannot occur without addressing the historical dispossession of the Traditional Custodians of the Wilsons River catchment. The NBS Project will support the development of a framework that embeds Widjabul Wia-bal leadership directly into the planning and implementation of future nature-based solutions. Guided by an Elders oversight group and undertaking waterway assessments will identify cultural objectives and outcomes for culturally important waterways, that can be used as a rationale for future funding, the development of cultural management plans, and direct employment on Country.

Conclusion

The NBS Project pilot is on track to demonstrate that projects using the site selection and planting design planting on critical riparian and floodplain zones on Tuntable and Terania Creeks, RLI has established a scalable blueprint for regional climate resilience. Future works will focus on other headwater streams in the Wilsons River Catchment to understand each streams' contribution to flooding.

The project will successfully demonstrate three core concepts:

- Targeted, proactive landholder engagement can deliver contiguous landscape density required for measurable hydrological change
- Grassroots community knowledge and citizen science can inform co-design and be integrated with university-led research to overcome data gaps in high-rainfall upper catchment
- Ecological restoration must be culturally informed. Catchment resilience is achieved when scientific research is paired with the traditional knowledge of the Widjabul Wia-bal people.

The NBS pilot stands as the first and only project of its kind in the flood-affected Lismore region. It will provide evidence that strategic revegetation as a nature-based solutions is a viable option to slow the flow of surface runoff in upper sub-catchments to mid to low floodplains downstream. To deliver this at the scale that needs to occur to have meaningful benefits to downstream communities the approach established in this pilot must be delivered at a landscape scale across of the upper sub-catchments of the Wilsons River catchment.

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