Sands through the hourglass: a 30-year journey towards rehabilitation of the Genoa River, East Gippsland Victoria

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Key points

- The Genoa River has a history of rehabilitation effort over 30 years, involving community, river managers and scientists.
- Continuous improvement of the understanding of processes driving change (both positive and negative) within the river have been critical in progressing management actions to improve river condition.
- System recovery is inherently a long-term process, however the results on the Genoa River demonstrate that sustained, process-based management can significantly accelerate recovery.
- The Genoa River demonstrates that meaningful improvement can be achieved within decades through consistent and informed intervention, providing an example for the management of similarly disturbed river systems within southeastern Australia.

Abstract

This paper describes the rehabilitation of the Genoa River over 30 years and lessons learned in protecting the river and Mallacoota Inlet from the impacts of extensive erosion and sedimentation.

Interventions commenced in the 1970's, but with poor understanding of river processes, works were small-scale, with little overall planning or coordination. A more holistic approach commenced in the late 1980's, with works locally effective, but the sand problem remained. Investigations by Dr Wayne Erskine, and a subsequent 'Expert Panel' process, identified the main sources of sediment and the geomorphic processes driving waterway condition. Work to control erosion upstream was initiated, inter-state cooperation commenced, and revegetation and the reintroduction of large wood to the river channel was undertaken. LiDAR and hydraulic modelling have been used to better understand contemporary processes, helping to inform further management approaches.

The Genoa River has experienced significant flood and fire impacts over this period. This provides insights into the challenges of building resilience in waterways, a challenge that will only increase under a changing climate.

Addressing the 'sand problem' on the Genoa River represents a relatively unique example of successful reach scale rehabilitation over an extended period. It includes the integration of community interest, scientific investigation, and management interventions based on clear objectives for the restoration of a waterway.

The recovery of the Genoa River is now clearly apparent, evidenced through ongoing geomorphic assessment and visible on ground outcomes, and it can provide a template for rehabilitation of similarly degraded sand bed streams in Southern Eastern Australia.

Keywords

Genoa River, sand bed stream, erosion, aggradation, reach scale river rehabilitation, revegetation, large wood

A system in decline: Widening channels and a landscape dominated by sand

The Genoa River, located in far eastern Victoria and extending into southern New South Wales, drains into Mallacoota Inlet and forms part of a coastal catchment that has experienced significant historical disturbance. As with many rivers in south-eastern Australia, European settlement resulted in widespread alteration of river and floodplain processes through land clearing, grazing and the removal of riparian vegetation and woody habitat from the river channel.

By the late twentieth century, the lower Genoa River had become dominated by sand and exhibited widespread instability. The channel had widened significantly, banks were actively eroding, and floodplain areas were being reworked. These changes generated increasing concern among landholders and managers, particularly regarding the potential downstream impacts on the estuarine environment. These concerns resulted in a ministerial inspection of the Genoa River in 1987.

The condition of the river reflected the combined effects of historical land use and extreme flood events. In particular, the 1971 flood represented a major disturbance event that triggered widespread channel erosion and redistribution of sand throughout the system. Landscape scale fires in the catchment in January 1979 and the early months of 1983 also likely increased sediment supply to the river. The legacy of these events was evident for decades, with large volumes of sand persisting within the channel and floodplain.

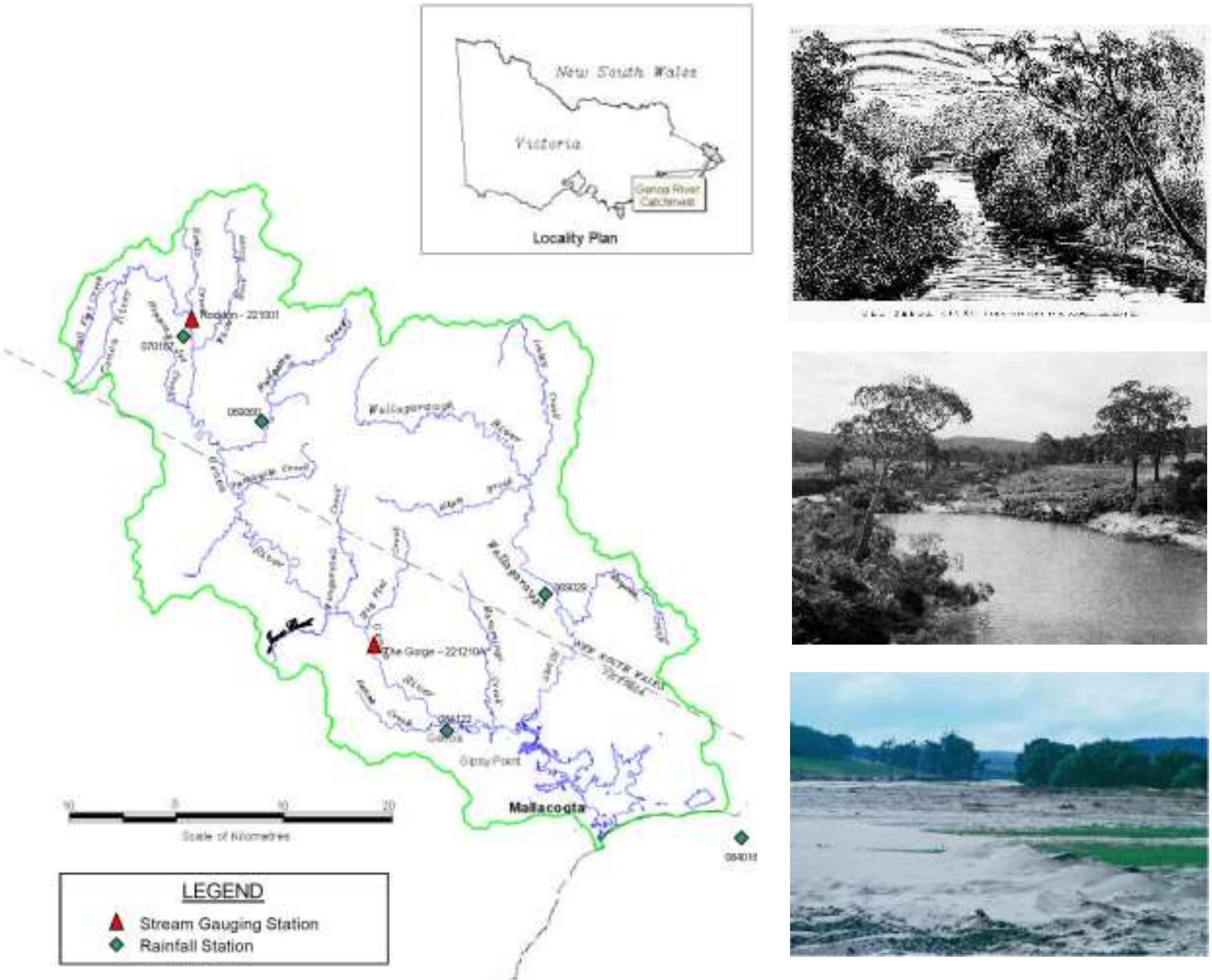

Figure 1 Genoa River catchment and locality map and images – a typical river channel circa. 1871 (top) and 1952 (middle); 1971 sand deposition on the floodplain following flooding (bottom) (reproduced from Brooks et al, 2001)

More than supply: Rethinking the origins of the sand problem

Initially, the accumulation of sand within the Genoa River was widely perceived as the result of excessive sediment supply from the catchment. Considerable debate existed regarding the relative contributions of forestry, road construction, agriculture and hillslope erosion, and there was strong community concern about the potential for ongoing coarse sediment delivery to the estuary.

However, early investigations revealed that the issue was more complex than a simple increase in sediment supply. Instead, the river appeared to be storing and redistributing large volumes of sediment -in the channel and floodplain, with sand undergoing repeated cycles of erosion, transport and deposition. This distinction between sediment supply and sediment storage proved to be critical in redefining both the problem and the appropriate management response.

Shifting understanding: Science redefines the river and its processes

The declining condition of the Genoa River prompted a series of scientific investigations aimed at identifying the causes of instability and informing management responses. These investigations, undertaken between the late 1980s and early 2000s, fundamentally reshaped understanding of sediment dynamics within the system and laid the foundation for long-term rehabilitation efforts.

Erskine (1992) provided the first comprehensive assessment of coarse sediment sources within the catchment and demonstrated that channel erosion was the dominant contributor of sand. This finding challenged prevailing assumptions that hillslope erosion or land use activities were the primary drivers of sediment supply. Whilst these sources, primarily emanating from New South Wales, were still identified as secondary contributors to the oversupply of sand, erosion of the channel itself was identified as the principal mechanism mobilising these sands within the Victorian reach of the river.

This work also identified the importance of major flood events in driving channel change. The 1971 flood, in particular, was shown to have caused extensive channel widening and erosion, releasing large volumes of sand from previously stable floodplain and in channel deposits. The sediment generated during this event remained within the system for extended periods, contributing to ongoing instability.

A key insight arising from this early work was the recognition that the Genoa River contained significant internal sediment stores. Rather than being rapidly transported downstream, much of the sand remained within the channel and adjacent floodplain, where it was repeatedly reworked during subsequent flows. This reframed the understanding of the river from a system dominated by sediment supply to one characterised by sediment storage and ongoing channel adjustment.

This geomorphic understanding was complemented by field investigations undertaken by Riparian Australia and other field staff in the mid-1990s, which examined the role of vegetation in stabilising the river system. These studies demonstrated that the distribution and condition of riparian and floodplain vegetation strongly influenced geomorphic processes. Unsurprisingly, areas subject to grazing pressure exhibited limited vegetation cover and extensive exposed sand, while fenced areas showed rapid natural regeneration of native species.

The results of these studies highlighted the capacity for vegetation to stabilise coarse sediment through increased hydraulic roughness, reducing energy within the river channel and promoting deposition. Follow-up surveys conducted over a two-year period confirmed that vegetation could rapidly colonise previously bare sand surfaces when stock access was removed and weed competition was managed.

Building on these investigations, the Genoa Expert Panel was initiated in 2001, and provided a comprehensive synthesis of sediment dynamics within the catchment (Brooks et al., 2001). The Panel confirmed that channel erosion remained the dominant sediment source and that hillslope processes and land use activities were generally secondary or localised contributors.

Importantly, investigations concluded that much of the sediment currently within the system represented legacy material mobilised during past disturbance events rather than ongoing high rates of contemporary supply. This finding reinforced the significance of historical channel adjustment and highlighted the long-term influence of major floods.

The Panel further conceptualised the river as a connected system comprising zones of sand production, transfer and storage. Steep, confined reaches were identified as efficient transfer zones, while lower gradient reaches functioned as major storage zones where coarse sediment accumulated and remained for extended periods. In particular, the Rockton, Wangarabell and lower Genoa reaches were identified as significant areas of sediment storage. Some of these areas were also identified as permanent sediment sinks, where large volume of material could be locked away and prevented from movement in all but the largest flood events.

A critical outcome of this work was the recognition that the lower Genoa River functions as a long-term sediment store (and in some cases a sink) and that much of the sand present in this reach is unlikely to move rapidly downstream and contribute to infilling of the estuary. This finding addressed longstanding concerns regarding the potential for large-scale coarse sediment delivery to Mallacoota Inlet and underscored the importance of in-channel and floodplain processes in attenuating coarse sediment transport.

The Panel also emphasised that recovery of the river must be considered over extended timeframes. While natural recovery processes are active, they may operate over decades or longer, particularly in systems with large sediment stores. However, the rate of recovery can be accelerated through appropriate management interventions that enhance natural stabilising processes.

Collectively, the investigations undertaken prior to 2000 established a robust scientific framework for understanding the Genoa River. They demonstrated that the sand issue is fundamentally a problem of channel adjustment and sediment storage, rather than ongoing excessive sediment supply, and they highlighted the central role of vegetation and geomorphic processes in driving recovery.

Figure 2 Project recovery trajectory of the Genoa River (reproduced from (Brooks et al., 2001)

Working with the river: From control to process-based rehabilitation

Following the identification of channel erosion as the dominant sediment source (Erskine 1992), the then East Gippsland River Management Board implemented an extensive and highly influential program of rehabilitation works across the Genoa River catchment. Practitioner accounts highlight that these works were undertaken in a severely degraded system and were characterised by innovation, experimentation and adaptive learning, with many techniques being developed in situ and tested over time.

At the outset in the early 1990s, the lower Genoa River was a highly unstable, sand-dominated system described as a deeply incised "bare trench", with extensive bank erosion, minimal vegetation and a uniformly mobile sand bed. Rehabilitation efforts therefore focused not only on controlling erosion, but on fundamentally altering the processes driving instability.

Early rehabilitation works focused on stabilising the channel and preventing further erosion using structural measures such as **bed grade control, alignment training and bank protection.** These interventions, applied at high-risk sites like Bridle's Bend, proved highly effective in maintaining channel alignment over the long term. Over time, approaches shifted away from rock-based designs toward more flexible, process-based methods. **Pile fields** emerged as a cost-effective way to stabilise alignment, and promote natural channel stability, while grade control measures, including **rock chutes**, in tributaries successfully reduced coarse sediment supply by addressing incision.

Implemented by the newly formed East Gippsland Catchment Management Authority in the early 2000's, a key innovation was the introduction of **large woody debris (LWD)** to increase bed roughness and improve channel function. Anchored logs reduced flow velocity, trapped sand, and created diverse hydraulic conditions, enabling localised scour and deposition. These features provided stable sites for vegetation establishment, helping overcome the barrier of high sediment mobility that had previously limited recovery. Over time, LWD-driven changes promoted broader channel stabilisation and reduced sand movement.

Riparian fencing and **stock exclusion** were among the most effective measures, leading to rapid vegetation recovery. Within a decade, previously bare and unstable banks became densely vegetated, significantly reducing erosion and sediment input. **Revegetation efforts** focussed on the reintroduction of local indigenous species, including the use of **long stem plantings**, supported by local nurseries and improved techniques, further enhanced bank stability and channel function (Riparian Australia, 1995; Riparian Australia, 1997). **Weed control** was used to support this process where natural recovery was limited. The native vegetation that establishment increased hydraulic roughness, and encouraged sand deposition and retention, particularly when combined with structure works in the channel.

Importantly, the approach recognised that effective management required a catchment-scale perspective. Interventions were prioritised in key reaches and tributaries that contributed disproportionately to sediment dynamics, and increasing emphasis was placed on coordination across jurisdictional boundaries. At the same time, management began to focus on enhancing floodplain and in-channel roughness to reduce flow energy and promote sand deposition.

Figure 3 Site of large wood installation in the Genoa River floodplain reach in 2002 (left) and 2009 (right). Note the establishment of in-stream vegetation and development of a narrow low flow channel

Taking stock: What 30 years of intervention has achieved

A detailed geomorphic assessment of the lower Genoa River was undertaken in 2023 to ascertain the progress of the system along the assumed recovery trajectory.

Where it worked - and where it struggled: Lessons from the field

The effectiveness of on-ground works varied strongly with local sediment dynamics and amount of vegetation establishment. In upstream reaches, high and ongoing sand supply has limited the performance of interventions such as LWD. Many logs have been buried, stranded on unvegetated bars, or failed to generate meaningful scour, indicating that bed mobility remains too high for these structures to consistently function as intended. While there is some evidence of localised benefit, such as the formation of small shadow dunes and limited vegetation establishment associated with individual logs, these outcomes are patchy and suggest that, in highly dynamic sand-dominated environments, structural works alone may have limited influence without sufficient stabilisation through vegetation.

Figure 4 Sites of LWD installation in the Genoa River in the upstream reach

In contrast, downstream reaches demonstrated more effective outcomes where vegetation establishment is stronger, and channel conditions are more stable. Here, LWD appears to have contributed to increased bed complexity, including deeper pools and more defined channels, while supporting the development of vegetated islands and inset floodplains. However, some engineered structures, such as groynes, pile fields, and rock chutes, show limited evidence of promoting sediment deposition or sustained vegetation growth, although they have helped maintain overall channel position and reduce the risk of major channel change.

Figure 5 Vegetation establishment in the Genoa River downstream reach

Overall, the effectiveness of works improves where there is interaction with, and reinforcement by, vegetation and reduced coarse sediment mobility. This highlights the importance of the establishment of appropriate native vegetation communities in determining the success of rehabilitation interventions.

Uneven recovery: A river progressing at different speeds

The available lines of evidence indicate that the Genoa River is progressing along a recovery trajectory, although this recovery is spatially uneven.

Reaches downstream are more advanced in their recovery than those upstream, as demonstrated by differences in channel form, vegetation establishment, and stability. In the downstream reaches, a longer period since the commencement of instream works and revegetation has allowed vegetation to establish and persist through high flows, contributing to increased channel stability. In contrast, upstream reaches remain more dynamic, with less established vegetation and greater susceptibility to disturbance.

A key factor influencing this divergence is the timing and persistence of sediment inputs. Upstream reaches have experienced more recent accumulations of sand, likely associated with post-bushfire erosion following the 2019/20 fires and potentially the reactivation of unstable tributaries, both within Victoria and New South Wales These inputs have produced extensive low-relief sand bars and contributed to the burial of instream wood.

Signs of renewal: A river regaining form and function

Over more than three decades, the Genoa River has shown clear signs of recovery. Riparian vegetation has become increasingly established along much of the river, leading to improved bank stability and reduced erosion. Vegetation has also colonised channel margins and sand benches, contributing to increased hydraulic roughness and promoting sand deposition.

As a result, the channel has undergone measurable contraction in many reaches, with a reduction in the extent of exposed sand and a more defined channel form. The volume of actively mobilised sediment has decreased, and many previously unstable sections are now relatively stable under moderate flow conditions.

While large flood events continue to play a significant role in driving change, the system now exhibits greater resilience, with vegetation and sediment storage processes acting to dampen the impacts of disturbance.

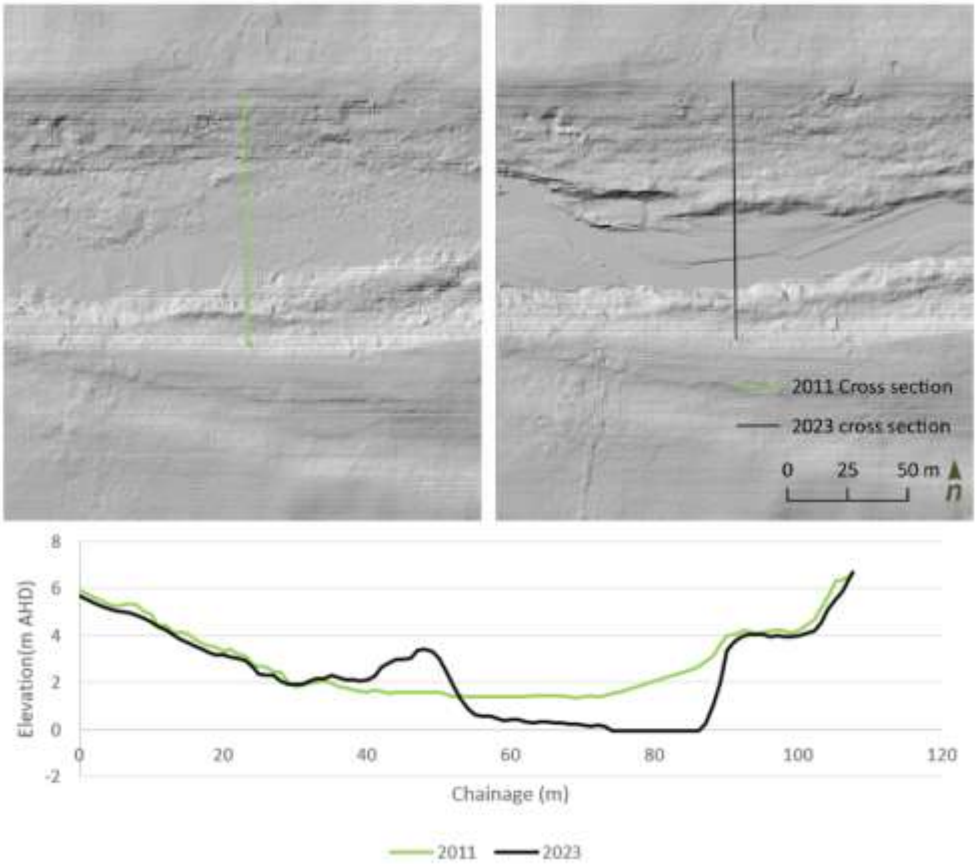

Figure 6 Cross section of the Genoa River downstream of the Princes Highway (in the reach shown in Figure 7). Showing 2011 and 2023 surface elevation (Alluvium, 2024). Note the change in channel form

Lessons from the Genoa: Recovery through process, patience and persistence

The Genoa River provides a clear illustration of the importance of geomorphic understanding in river management. Early assumptions that the sand problem was driven by excessive sediment supply led to uncertainty and debate regarding appropriate management responses. However, the development of a process-based understanding revealed that the issue was fundamentally one of channel adjustment and sediment storage.

This shift in understanding enabled a corresponding shift in management approach. Rather than attempting to remove sand or control the river through engineering works, management focused on enhancing natural processes that promote stability. The achievement of a primarily stable channel alignment through management interventions increased the likelihood of establishment of riparian and instream vegetation, which emerged as the key mechanism through which change could be realised, influencing both flow dynamics and sediment behaviour.

The presence of large coarse sediment stores and sinks within the system means that recovery is inherently a long-term process. However, the results achieved to date demonstrate that sustained, process-based management can significantly accelerate recovery and improve system resilience.

Although recovery operates over very long timescales, the Genoa River demonstrates that meaningful improvement can be achieved within decades through consistent and informed intervention. As such, it provides a valuable example for the management of similarly disturbed river systems within southeastern Australia.

Figure 7 The Lower Genoa River before (1986) (left) and after (2010) (right) an extensive rehabilitation project downstream of the Princes Highway in Genoa

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