Rapid geomorphic recovery of the Erskine River wave-dominated estuary after flash flooding

Sandra Brizga[1]

1 Brizga Environmental, Clifton Hill, Victoria, 3068. Email: brizgaenvironmental@icloud. com

Key points

- A major flash flood occurred in the Erskine River, Victoria on 15th January 2026
- The Erskine River estuary is an Intermittently Open/Closed Estuary (IOCE) that is usually partially open, with estuarine hydrodynamics controlled by a sand bar at the river mouth
- The January 2026 flood scoured sand out of the lower estuary and entrance bar, lowering the control for the estuarine lagoon and temporarily lowering water levels throughout the estuary
- Coastal processes rapidly reconstructed the entrance bar, restoring water levels in the estuary to pre-flood levels
- The rapid re-establishment of the entrance bar has implications for estuary management because of the strong influence of the entrance bar on estuarine hydrodynamics and water quality

Abstract

The Erskine River catchment is situated in the Otway Ranges and discharges to Loutit Bay at Lorne, Victoria. Its estuary is an Intermittently Open/Closed Estuary (IOCE) extending approximately 1 km inland from the coast. The estuary is usually partially open with the water level in the estuary controlled by a sand bar at the river mouth but is subject to complete closure during dry periods.

An intense rainfall event on 15th January 2026 associated with a slow-moving storm cell caused flash flooding in the Erskine River that scoured the entrance bar and lower estuary, evacuating the sand from these areas into Loutit Bay. The flood exhumed the remains of a nineteenth century shipwreck at the river mouth. The base level for the estuary was temporarily lowered, lowering water levels throughout the estuary and exposing features that are rarely seen, including cobble bars in the upper estuary, and sand and mud banks in the middle estuary.

Field observations showed rapid geomorphic recovery. Within weeks of the flood, wave action had reconstructed the entrance bar and water levels in the estuary were soon restored to pre-flood levels. Onshore waves driven by easterly winds in the fortnight after the flood contributed to the rapid recovery. Understanding natural estuary opening and closing processes, as shown by the response to the January 2026 flood, has important implications for management of the estuary because of the strong influence of the entrance bar on estuarine hydrodynamics and water quality.

Keywords

Flash Flooding, Intermittently Open/Closed Estuary (IOCE), Partially Open Estuary

Introduction

Intermittently Open/Closed Estuaries (IOCE) (also known as “Intermittently Closed/Open Lakes and Lagoons [ICOLLs] or “Temporarily Open/Closed Estuaries” [TOCE]) are wave-dominated estuaries subject to periodic closure. There has been considerable research interest in the geomorphological and ecological dynamics of IOCE. In western Victoria, this includes ecological work by Sherwood (e. g. Sherwood et al. 2008) and studies by McSweeney and her colleagues on geomorphological processes in western Victorian IOCE including the Anglesea River, Painkalac Creek, Spring Creek, Aire River, Gellibrand River, and Curdies Inlet (McSweeney et al. 2016, 2018a, 2018b, McSweeney and Stout 2019). The Erskine River estuary was included in the Corangamite Catchment Management Authority’s

(CCMA's) EstuaryWatch program, a community based, citizen science estuary monitoring program (CCMA 2025) which includes photopoint data, but all the Erskine River sites are currently inactive (WaterWatch 2026). There have been no previous geomorphological studies of the Erskine River estuary.

A major flash flood occurred in the Erskine River and neighbouring catchments on 15th January 2026. Rain gauges near the head of the catchment recorded daily rainfall totals of 150 mm (Benwerrin) to 190 mm (Mt Cowley), most of which occurred over a three-hour period. The flood event attracted considerable media attention because Lorne and the surrounding areas are popular summer holiday destinations, and the flash flood swept through camping grounds, carrying camping equipment downstream, as well as cars and caravans in the Cumberland and Wye Rivers. This paper provides an assessment of the effects of the flood on the geomorphology of the Erskine River estuary, including geomorphic recovery processes after the flood.

Study area

Context

The Erskine River drains a 30.4 km^2 catchment in the Otway Ranges and discharges to Loutit Bay at the northern end of the Lorne Main Beach. Mean annual rainfall ranges from around 900 mm (Lorne) to around 1250 mm in the headwaters. The catchment area is largely steep and forested (about 80% is situated in the Great Otway National Park) while the coastal town of Lorne extends into the lower part of the catchment, and the estuary receives stormwater runoff from Lorne. The estuary is about 1 km long.

The geology of the Erskine River catchment consists primarily of Cretaceous Eumeralla Formation sedimentary rock (sandstone, siltstone, mudstone and conglomerate), with Tertiary and Quaternary coastal deposits at the downstream end of the valley. The modern beach consists of calcareous sand derived from marine sources (Davies 1989). The Erskine River flows in a generally south-easterly direction but in the middle section of the estuary it makes a sharp turn to the north-east, following the alignment of the Lorne Syncline.

Loutit Bay is part of Bass Strait but is partly sheltered from the prevailing south-west swells by Point Grey. It has a semidiurnal microtidal regime with a spring tide range of 1. 6 m. Digital Earth Australia (DEA) Coastlines (Bishop-Taylor et al. 2021) shows Lorne Main Beach has been stable over the period of coverage (1988 to 2025), with greater fluctuations in mean shoreline position near the Erskine River mouth, where there has been minor net advancement of the shoreline position.

Erskine River Estuary

The Erskine River estuary is an IOCE, with three main sections (Figure 1). The pre-flood condition of the estuary and longer-term dynamics of the estuary have been characterized based on available documentary sources (including recent and historical aerial imagery, historical photographs and EstuaryWatch data) and my personal observations over the past decade.

Upper estuary

The upper estuary consists of a river channel that is inundated by backwater from the entrance bar and subject to tidal influence when the entrance is fully or partially open. Remnant native riparian vegetation is present along the channel margins.

Middle estuary

The middle section of the estuary is wider than the upper estuary. It includes the main section of the estuarine lagoon and a broad area of marshland that borders the lagoon on the southeastern side. The lagoon is maintained by backwater from the entrance bar. Tidal and coastal influences are more prominent than in the upper estuary. Historical aerial imagery (dating back to 1947) and earlier historical photographs confirm the general configuration of the middle estuary has remained consistent throughout the period of historical records.

Lower estuary

The lower estuary includes the downstream end of the estuarine lagoon and the entrance bar. The entrance bar is shaped by coastal waves, tides and river outflows. Historical maps and aerial imagery (including GoogleEarth imagery from May 2006 to February 2023, colour aerial photographs from 1975 and 1993, and black and white aerial images dating back to 1947) show that the estuary is usually partially open, with outflows discharging through a thalweg across the entrance bar. A flood tide delta is sometimes present on the upstream side of the entrance bar.

Occasionally, during dry periods, the entrance to the estuary is completely closed. Complete closures do not persist for long. The estuary has a history of artificial openings to address flooding of the adjacent caravan parks and water quality concerns (Franke 2000). The current policy is for the river mouth not to be artificially opened but illegal openings have continued to occur. The natural duration of periods of total closure is not known, consistent with McSweeney et al. 's (2018) observation that most IOCE are artificially opened before the natural opening threshold is reached.

Historical aerial imagery shows the mouth of the Erskine River has remained within an area between the shore platform at the northern end of the Lorne Main Beach and about 200 m to the south. Bedrock outcrops have prevented further northward migration of the river entrance. However, there have been changes in the configuration of the estuarine outlet channel across the entrance bar, and changes in the presence and extent of flood tide deltas within the estuarine lagoon.

Figure 1 Erskine River Estuary. Source: MapShare Vic (2026)

January 2026 flood

The Flood

An intense rainfall event on 15th January 2026 associated with a localized, slow-moving storm cell caused flash flooding in the Erskine River and neighboring catchments. The Erskine River is ungauged, but streamflow

records are available for the nearby Cumberland River, which showed the 15th January flood was the second largest flood on record (the period of record dates from 1971). The flood hydrograph shows the rapid rise and fall in water level (Figure 2),

Anecdotal accounts, photographs published in the media and social media, and my field observations on the day after the flood (16th January 2026) indicate similarly rapid rise and fall in Erskine River water levels. Tide charts and sea level records for Lorne confirmed the flood peak coincided with an outgoing tide (Figure 2).

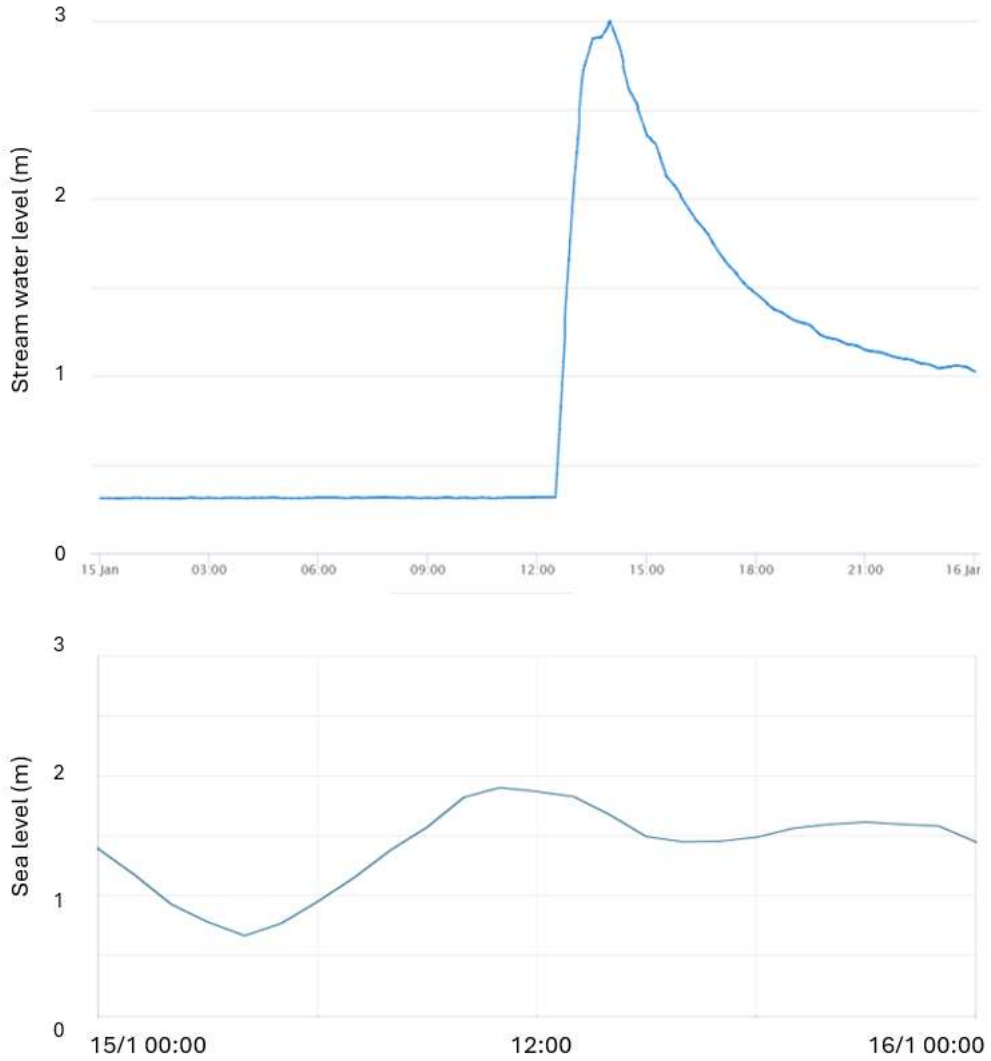

Figure 2 Stream water level in the Cumberland River at Lorne (upper graph) and sea level at Lorne (lower graph) on 15th January 2026. (Source: Victorian Water Management Information System, 2026 and Bureau of Meteorology 2026)

Geomorphological impacts on the Erskine River Estuary

The geomorphological impacts of the flood and post-flood recovery processes were assessed based on my field observations and photographs published in the media (including social media). There was no publicly available post-flood aerial imagery at the time this paper was written.

The flood eroded a channel through the entrance bar (Figures 3a, 3b and 3c) and flushed sand deposits out of the lower estuary into Loutit Bay. The flood cut exposed Eumerella Formation bedrock in the lower estuary and an old shipwreck usually buried under sand at the entrance bar (Lorne Historical Society 2026; Figures 3b and 4a).

The scour of the entrance bar lowered the base level for the estuary, draining the estuarine lagoon. Sand and mud banks were exposed in areas usually under water (Figure 3d, 4b). In the upper estuary, areas of river bed that are usually submerged by backwater from the estuarine lagoon were exposed by the fall in water level, including cobble and rock bars downstream of the Great Ocean Road (Figure 4c).

Organic matter and fine sediments were deposited on the floodplain. The flood waters discharged a plume of sediment and terrestrial organic matter from the Erskine River into Loutit Bay. Timber and leaf litter were washed up onto the Lorne Main Beach over subsequent days and weeks. Similar plumes were also associated with the other nearby waterways affected by flash flooding, including the Wye and Cumberland Rivers.

(a)

(b)

(c)

(d)

Figure 3 Photographs showing the effects of the flood on the Erskine River estuary (all photographs around low tide): a) entrance bar and flood cut from south bank, 16 January 2026, b) exposed shipwreck, 17 January 2026, c) flood cut from north bank, exposed shipwreck arrowed, 17 January 2026, d) sand and mud banks exposed by fall in control level, 17 January 2026

Post-flood recovery

Geomorphic recovery was rapid. Wave action quickly deposited sand onto the entrance bar (Figure 4c), re-burying the shipwreck and re-establishing the control that maintains the estuarine lagoon (Figure 5). Within a few weeks, the river bed in the upper estuary (Figure 4c) and sand and mud banks in the middle estuary (Figure 4b) were again submerged by backwater from the entrance bar, which modifies tidal exchange including the effects of tides on water levels in the estuary. Measurements over several tidal cycles between 30 April and 4 May 2026 showed the tidal range in the middle estuary at the Swing Bridge was less than 1 m, compared to 2 m in Loutit Bay. A flood tide delta is developing in the estuarine lagoon immediately upstream of the entrance bar (Figure 4a).

a) Lower estuary

Flood cut – January 2026

Flood tide delta – March 2026

b) Middle estuary

Exposed sand and mud banks – January 2026

Resubmerged sand and mud banks – May 2026

c) Upper estuary

Exposed river bed – January 2026

Resubmerged river bed – May 2026

Figure 4 Photographs showing examples of flood effects and post-flood recovery in the lower, middle and upper estuary

Meteorological records and data from the nearest Victorian wave monitoring station (Apollo Bay) show that easterly winds and waves prevailed in the fortnight immediately after the flood, rather than the more typical southwesterly winds and waves (Figure 6). Easterly waves appear to have been favorable

for reconstruction of the east-facing entrance bar. My most recent site inspection (5th May 2026) showed the estuary remained partially open and was being kept open by a combination of river flows and tidal currents.

McSweeney et al. (2018a) identified two modes of entrance closure, lateral accretion (gradual estuary closure by longshore drift-driven spit growth during low river flows) and vertical accretion (rapid aggradation under high, near- normal waves). The post-flood recovery of the Erskine River estuary is consistent with the vertical accretion mode of entrance closure.

Figure 5 The entrance bar control for the estuarine lagoon (May 2026)

Figure 6 Ocean wave height and direction at Apollo Bay, 15 January 2026 to 21 May 2026. The arrows point in the direction the waves are travelling. (Source: https://auswaves. org/vic-waves/)

Management implications

As noted above, the Erskine River estuary has been subject to artificial openings (in recent years undertaken illegally, contrary to the CCMA's policy) to address concerns about water quality and local flooding. This paper has shown coastal geomorphological processes have a strong influence on the

entrance bar, which exerts a critical control on estuarine hydrodynamics, a key factor in relation to water quality and flooding issues.

The rapid post-flood recovery of the Erskine River estuary has implications for water quality management. The January 2026 flood flushed and drained the estuary but rapid reestablishment of the entrance bar by natural coastal processes quickly returned the estuary to a state with longer residence times conducive to pollutant accumulation and water quality deterioration. In this context, it is important to minimize pollutant inputs to the estuary to maintain water quality.

Conclusion

This paper has presented a case study on the effects of a major flash flood on the Erskine River estuary, a small IOCE. The main effect of the flood was temporary lowering of the sand bar at the entrance, which led to falls in water levels throughout the estuary, draining the estuarine lagoon and exposing usually submerged features. Coastal geomorphological processes rapidly re-established the entrance bar, reinstating the estuarine lagoon and backwater, and controlling the degree of tidal influence. At the time of writing this paper, the estuary remained partially open, which historical records show is the usual state. The strong influence of entrance bar processes on estuarine hydrodynamics highlights the importance of understanding the geomorphology of the Erskine River estuary as a basis for estuary management.

References

Bishop-Taylor, R., Nanson, R., Sagar, S., Lymburner, L. (2021). Digital Earth Australia Coastlines. Geoscience Australia, Canberra. https://doi.org/10.26186/116268 [Accessed 22 May 2026]

Corangamite Catchment Management Authority (2025) Estuary Watch. https://ccma.vic.gov.au/get-involved/estuary-watch/, viewed 22 May 2026.

Davis Jr, R. A. (1989). Texture, composition and provenance of beach sands, Victoria, Australia. *Journal of Coastal Research,* 37-47.

Franke, B. (2000). Erskine River and Stony Creek Catchment Plan. Report prepared for Corangamite CMA and Surf Coast Shire.

Lorne Historical Society (2026) Ship wreckage uncovered. https://www.lornehistoricalsociety.org.au/timeline/ship-wreckage-uncovered/, viewed 22 May 2026.

McSweeney, S. L., Kennedy, D. M., & Rutherfurd, I. D. (2016). When is artificially opening Intermittently Closed Estuaries (ICE) most effective. In P*roceedings of the 8th Australian Stream Management Conference Queensland, Blue Mountains*, New South Wales (pp. 1-8).

McSweeney, S. L., Kennedy, D. M., & Rutherfurd, I. D. (2018a). The daily-scale entrance dynamics of intermittently open/closed estuaries. *Earth Surface Processes and Landforms*, 43(4), 791-807.

McSweeney, S. L., Stout, J. C., Rutherfurd, I. D., & Kennedy, D. M. (2018b). Predicting the entrance opening duration of Intermittently Open/Closed Estuaries (IOCE) in Victoria. *Proceedings of the 9th Australian Stream Management Conference* (pp. 414-422).

McSweeney, S. L., and Stout, J. C. (2019) *Field observations of geomorphic change during artificial estuary openings*. Report prepared for: Corangamite Catchment Management Authority (CCMA). December 2019.

Sherwood, J., Mondon, J., & Fenton, C. (2008). Classification and management issues of estuaries in western Victoria, Australia. *Proceeding of the Royal Society of Victoria*, 120, 257-276.

WaterWatch (2026) EstuaryWatch Data Portal. Erskine River Estuary. https://ew-data.waterwatch.org.au/estuary/ccma/47, viewed 22 May 2026.