

LARGE SCALE IMPACTS OF JETTIES AND TRAINING WALLS - EXPERIENCE ON THE AUSTRALIAN EAST COAST

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INTRODUCTION

Entrance jetties and training walls have instigated fundamental perturbations to coastal and estuary processes at several locations on the Australian eastern seaboard inducing long term changes to foreshore alignments, tidal current velocities, tidal plane elevations and marine ecologies with significant consequences, some having been realised only recently.

This paper presents examples of long-term impacts of entrance jetties and training walls on coastal and estuary processes, gleaned from experience on the NSW coast.

COASTAL PROCESSES

On coastlines with high transport rates of littoral drift, jetties have trapped sand inducing erosion on down-drift beaches at the Tweed River (Delft 1970) and Coffs Harbour (Lord & van Kerkvoort 1981).

Another less-appreciated impact of jetties on coastal alignments has been the changes they can induce in near-shore wave patterns that, in turn, will re-align ocean foreshores significantly (Miller & Nielsen 1995, Klein *et al.* 2003, Gordon 2011). Essentially, a long breakwater can act as a headland inducing a crenulated-shaped bay onto what may have been a relatively straight beach, generating areas of erosion and accretion.

Between 1898 and 1912 an 890 m long jetty was constructed on the northern side of the Hunter River ocean entrance. This had a significant impact on the shoreline at Stockton. The jetty cut off the flood tide channel that had run south along the beach and into the entrance. The result was not only the effective removal of the entrance sand bar but, by cutting off southerly wave influences in its vicinity, also resulted in a significant accretion of sand on the northern side. This accretion moved the shoreline approximately 300 m seaward at the jetty and resulted in a buildup of beach sand estimated to be in the order of two million cubic meters (see Figure 1).

However, beach erosion to the north was induced as the shoreline responded to the changed tidal flow and wave conditions. A software package called Model for Equilibrium Planform of Bay Beaches (MEPBAY; Klein *et al.* 2003) was used to calculate the shoreline planform of Stockton Beach prior to jetty construction (Figure 1 right). This modelled shoreline was verified by reference to historical surveys (Figure 1 left) and indicated both the accretion that has occurred on the northern side of the jetty and the severe erosion that has occurred on Stockton Beach resulting from the formation of a crenulated-shaped embayment.

The erosion has continued due to both the realignment of the beach and the net loss of sand blown into the dunes of Newcastle Bight (Gordon & Roy, 1977). This has resulted in the requirement to construct a rock revetment to protect Mitchell Street and the village (Figure 2). More recently it has been necessary to undertake beach nourishment to offset the on-going coastal recession.



Figure 1 - Left: Entrance to Newcastle Harbour (circa 1850). Right: Present-day entrance with MEPBAY 1850 predicted shoreline superimposed indicating foreshore realignment and severe erosion and accretion.



Figure 2 - Left: Rock revetment to protect Mitchell Street Right: Severe erosion north of the rock revetment

ESTUARY PROCESSES

Field data and hydraulic theory confirm that jetties have increased the tidal conveyance of entrance channels by removing sand bars, extraneous littoral currents and associated sand movements that, previously, impeded ebb tide discharges (Nielsen & Gordon 1980, 2008, 2011, 2015, 2016; Couriel *et al.* 2013). Comprehensive water level monitoring in several NSW coastal lakes where entrance jetties have been constructed has shown that tidal ranges have been increasing steadily for decades (Figure 3), if not centuries in the case of Lake Macquarie, with high tide planes rising, low tide planes falling, tidal velocities increasing, channels scouring and tidal deltas growing, all having adverse impacts on marine ecologies.

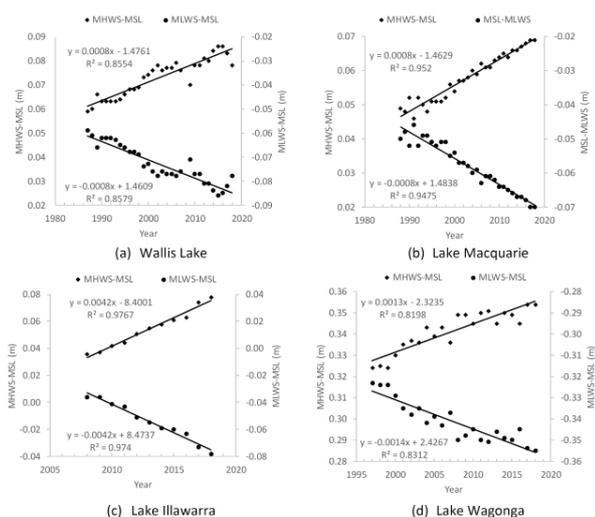


Figure 3 - History of changes in spring tidal planes in (a) Wallis Lake, (b) Lake Macquarie, (c) Lake Illawarra and (d) Lake Wagonga. Notes: various scales; Data courtesy of NSW Office of Environment and Heritage.

Training walls also can cause scour. A channel with a single training wall can have 16% higher discharge and a channel with twin training walls can have 20% higher discharge than a natural channel of equivalent cross-sectional area (Nielsen & Gordon 2016), increasing velocities and, potentially, channel scour (Figure 4).



Figure 4 - Swansia Channel foreshore building collapse due to bed scour (Photo: 8/2/2016 Fire & Rescue NSW).

CONCLUSIONS

Jetties constructed at estuary entrances have the potential to alter fundamental coastal and estuary processes inducing changes that evidence indicates may take centuries to resolve. While many beneficial and adverse impacts of jetty construction have been known for many years, such as the improvements to navigation and flood mitigation from rainfall runoff and the interruption to littoral drift transport causing down-drift erosion, some impacts of jetties and training walls have not been well understood and have been identified only recently, such as:

- Jetties can change local wave transformation patterns, inducing large scale beach re-alignments
- Jetties and training walls can enhance tidal conveyance, increasing the tidal prism and tripping an entrance channel into an unstable scouring mode
- Jetties can increase the conveyance inland of elevated ocean water levels.

Such changes may have adverse impacts, including:

- Coastal erosion and loss of development
- Dangerous boating conditions causing injury/death
- Channel scour causing damage to infrastructure, development and loss of seagrass
- Changing fringing marine habitat impacting fisheries
- Sediment deposition smothering seagrass
- Inland flooding from elevated ocean levels.

A broader understanding and consideration of the impacts of jetty and training wall construction is warranted.

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