

Tweed River Entrance Sand Bypass Project

Contribution of this case study

One of the key adaptation challenges for coastal settlements and infrastructure is responding to existing and future erosion hazards as sea levels rise. While there are numerous options available to decision-makers, the real or perceived tradeoffs can place social and political barriers in the way of adoption. Often seawalls are opposed for fear they will have negative impacts on beaches, and planned retreat is resisted by those whose properties are impacted. The Tweed River Entrance Sand Bypass Project (TRESBP) provides an example of how engineering can work with natural processes to accommodate multiple, and sometimes competing, priorities for coasts and beaches.

Background

Home to more than 500,000 people, Queensland's Gold Coast stretches along almost 40 km of beaches to the north of the Tweed River (see Figure 1). Tourism is worth around \$4 billion per year to the area, with beaches recognised as key attractions for tourists. While its beaches are an important asset, for such a large population centre, the close proximity to a sandy shoreline creates serious challenges.



Figure 1: Location of the project. Source: Acworth and Lawson 2011, © NSW Department of Industry.

According to a 2009 coastal risk assessment by the Australian Government, the Gold Coast has more buildings in erosion prone areas than any other local government area in the country.

The Gold Coast has been subject to numerous erosion protection works, however the TRESBP has had one of the most enduring impacts on the condition of the area's southern beaches. The TRESBP is an ongoing partnership between the state governments of Queensland and New South Wales (NSW) and the Gold Coast City Council. The Project pumps sand from NSW into Queensland, 'bypassing' the Tweed River entrance. In bypassing the Tweed River entrance the TRESBP keeps the entrance open to navigation while simultaneously supplying sand to Gold Coast beaches, improving their resilience to erosion.

Why was the TRESBP required?

The agreement to undertake the TRESBP is the result of decades of negotiations between the NSW and Queensland Governments. These talks started in the 1980s when it became apparent that the 1962 public works project by the NSW Government to extend the Tweed River training walls by 400 m was interrupting the transport of sand by current and drift from NSW into Queensland.

The Tweed River training walls were extended to improve the safety of navigation at the Tweed River entrance. At the time the entrance was infilled with sand due to longshore transport pushing sand from south to north across the entrance at an average rate of 500,000 m³/year. The resulting shallow water and breaking waves created a treacherous crossing with vessels frequently running aground as they entered the river. The extended walls kept longshore transport from infilling the entrance by trapping sand to the south of the river and as a result providing a deep water channel for vessels to use when entering the river, significantly improving navigation safety.

The impact of the interruption to the flow of sand to Queensland beaches was highlighted when in 1967 a series of tropical cyclones and storms caused such significant erosion damage to Gold Coast beaches that the Army Reserve had to be mobilised to sandbag beaches to reduce damage to buildings and infrastructure. It would

take another decade to recognise that while the series of storms contributed to the erosion, the interruption to sand flowing into Queensland led to the damage as the reduced volume of sand on beaches made the area more vulnerable to erosion.

Following the devastation of the 1967 storms the Queensland Government commissioned the Delft Hydraulics Institute to examine Gold Coast erosion and recommend solutions. The investigation concluded in 1970 with the release of what is referred to as 'the Delft Report' (Delft Hydraulics Laboratory 1970). The Delft Report did not identify the extended training walls across the Tweed River as having a significant impact on Gold Coast beaches. The report reached the conclusion that the water off Point Danger was too deep to allow longshore transport from NSW into Queensland. Instead the report focused on the dynamic nature of Gold Coast beaches and recommended a series of massive beach renourishments to provide a buffer against erosion rather than a focus on restoring longshore transport.

The Queensland Government also responded to the 1967 storms by passing the 1968 Beach Protection Act. The first example of coastal management legislation in Australia, the Act allowed for the establishment of the Queensland Beach Protection Authority to improve the understanding and management of erosion and beach protection across the state.

As the coastal engineering capacity within the Queensland Government developed through the 1970s, the conclusions of the 1970 Delft Report started to be questioned. In 1981 the Queensland Beach Protection Authority released a report on Gold Coast longshore transport which found no evidence to support the 1970 Delft Report finding that sand was being lost off Point Danger (Beach Protection Authority 1981). The report also found that the Tweed River training walls were the primary obstruction to longshore transport of sand and were having a much more serious impact than the 1970 Delft Report had found.

How was an agreement to develop the TRESBP reached?

Storms continued to cause significant damage to Gold Coast beaches through the 1970s and 1980s. The erosion damage caused direct impacts through damage to private and public property as well as indirect impacts to the area's tourism economy. Media reports in Sydney and Melbourne of Gold Coast beach erosion reduced visitor numbers, as the beaches were a key lure to the area.

As the flow of sand into Queensland was restricted, Gold Coast beaches were slow to recover following erosion events. In response to the Delft Report and ongoing erosion, the first major beach renourishment was completed in 1975 when 1,000,000 m³ of sand was placed at Kirra. The impact of the renourishment works was temporary and as the cost of seawalls, groynes and beach renourishments mounted, together with the impact of lost tourism income, the Queensland Government commenced negotiations with the NSW Government to resume the longshore transport of sand into Queensland.

The Queensland view was that the extension of the Tweed River entrance training walls had restricted sand supply to Queensland beaches increasing their vulnerability to erosion. The Queensland stance was that it had a right to the flow of sand from NSW. On this basis, a number of threats were made by Queensland politicians to take the NSW Government to the High Court of Australia to reinstate the sand flow.

From a NSW perspective the issue didn't attract a great deal of attention until the late 1980s. Initially the NSW response was to reject the position that sand flowed from NSW into Queensland – a position justified by the findings of the 1970 Delft Report.

As understanding developed of the area's coastal processes, it became difficult for NSW to maintain the argument that sand did not flow into Queensland. NSW shifted its position to rejecting Queensland's claim of ownership to the sand flow. This was on the basis that coastal resources such as sand are owned by the state in which they are located.

The NSW claim to ownership of the sand trapped by the extended Tweed River Training Walls was supported by federal laws:

- The Australian Constitution doesn't recognise

the potential for natural resources to be mobile and, as such, there is no allocation of rights to the maintenance of such flows between states.

- The Offshore Constitutional Settlement 1989 (Commonwealth) clarified the obligations for resource management between states and the Australian Government. Under the agreement, states are responsible for resources up to three nautical miles offshore, where the Australian Government takes over. Within this context, sand trapped by the Tweed River training walls is a NSW resource, not an issue for the Australian Government and something that Queensland would be unlikely to successfully prosecute in the High Court of Australia.

In light of the difficulty of negotiations with NSW, the Gold Coast City Council undertook a series of major beach nourishments through the 1980s including:

- 1985 Kirra 315,000 m³
- 1988 Kirra/Billinga 1,500,000 m³
- 1989/90 Southern Gold Coast 3,600,000 m³.

These beach nourishments reduced the vulnerability of Southern Gold Coast beaches to erosion. This decreased the urgency of finding a solution to the interruption of longshore transport caused by the 1962 extension of the Tweed training walls, however reinstating the flow of sand remained an issue for the long-term health of Gold Coast beaches.

By 1989 so much sand had accumulated at the southern Tweed River wall that the entrance was infilling and navigation had become increasingly hazardous. In response to community and industry concerns about the condition of the entrance, the NSW Government Public Works Department commenced a project to identify and review options for improving navigation safety at the Tweed River. The project considered economic and social issues, archaeology, coastal processes, navigation and the potential to establish an alternative river entrance at three locations: Letitia, Fingal and Wommin. After two years the project administrators concluded that the best option to improve navigation safety was the construction of a permanent sand bypass at the Tweed River's current entrance.

The gradual infilling of the entrance by longshore transport had aligned the interests of the NSW and Queensland Governments over time to the

degree that in March 1994 a Heads of Agreement was formalised between the states. The agreement specifies the following objectives:

"In seeking to maintain and enhance the attributes of this region, specifically the Tweed River estuary and the southern Gold Coast beaches, NSW has broadly defined its objective as establishing and maintaining an improved navigable entrance to the Tweed River, and Queensland has broadly defined its objective as achieving a continuing supply of sand together with the supply of an initial quantity of sand to the Beaches to restore amenity" (NSW and Queensland Government 1994).

What options were considered?

A number of alternative solutions were identified by the NSW and Queensland Governments prior to the commencement of the TRESBP. Each option was examined in the 1997 Environmental Impact Assessment for the TRESBP (Hyder Consulting et al. 1997) and is summarised below:

- **Construct a new entrance** - the Tweed Entrance Feasibility Study contains options for an alternative entrance to Tweed Heads to improve navigation safety. The study, funded by the NSW Government, compared three possible alternative entrances to the Tweed River at Letitia Spit, Fingal and Wommin with the current entrance at Tweed Heads. The project found that while it was possible to create an alternative entrance to the Tweed River, the costs of such a project could not be justified.
- **Do nothing** - this option would result in continued infilling of the entrance and lower reaches of the river. This infilling would cause significant tidal attenuation and interference with flow rates, increasing flood risk for the catchment which has developed significantly since the river was last in such an infilled state in the 1930s and 1960s. In addition, the restriction of sand supply would continue to be an issue for southern Gold Coast beaches, and waves on the resulting bar would hamper the ability of the fishing industry to operate offshore.



Figure 2: TRESBP System Overview. Source: Acworth and Lawson 2011, © NSW Department of Industry.

- **Dismantling the Tweed River training walls** - once the walls are removed, sand would move north quickly in slugs which would significantly interfere with navigation across the Tweed River entrance and would result in the infilling of the lower Tweed River which could increase flood risk and reduce water quality.
- **Major extension of the training walls** - this would improve navigation safety at the entrance. However, it would continue to restrict the flow of sand north into southern Queensland. The cost of extending the seawalls would be significant as they would be in much deeper water and would require significant risk armour to protect from wave attack.
- **Install a sand bypass system** - a system of jetties, dredges, pumps and pipes to allow sand to be pumped from Letitia Spit (in NSW) to Snapper Rocks (in Queensland) 'bypassing' the Tweed River entrance. This would result in maintenance of a safe channel for navigation at the mouth of the Tweed River, while maintaining a flow of sand along the coast (see Figure 3 and Figure 4).

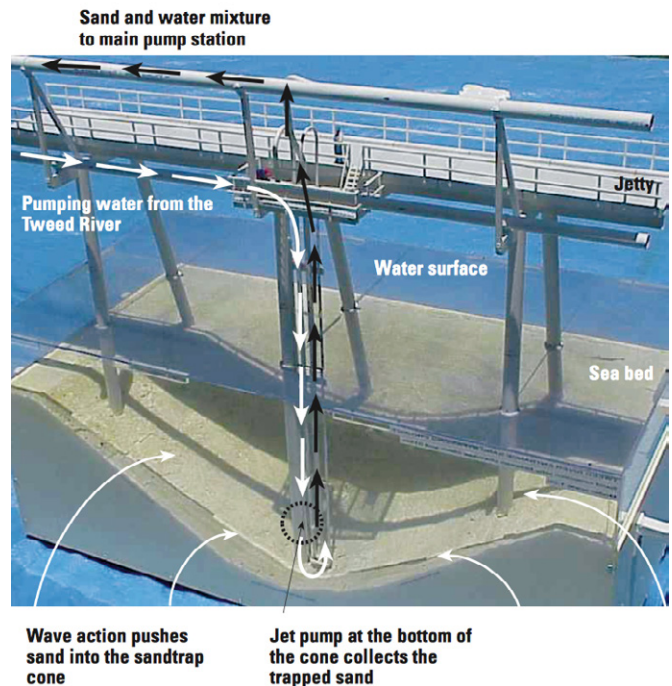


Figure 3: TRESBP System Overview. Source: Foster et al. 2001, © NSW Department of Industry.

The preferred option from social, economic and environmental perspectives was the installation of a sand bypass system.

Table 1: Annual costs of TRESBP by State.

Year	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
NSW	\$2.9 M	\$3.5 M	\$5.5 M	\$6.4 M	\$5.3 M	\$5.3 M	\$5.5 M	\$5.3 M
QLD	\$1.8 M	\$2.6 M	\$3.8 M	\$4.9 M	\$3.9 M	\$3.9 M	\$4.1 M	\$3.9 M
Total	\$4.7 M	\$6.1 M	\$9.3 M	\$11.3 M	\$9.2 M	\$9.2 M	\$9.6 M	\$9.2 M

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
NSW	\$4.6 M	\$5.6 M	\$4.1 M	\$4.1 M	\$4.1 M	\$4.2 M	\$1.9 M	\$2.5 M
QLD	\$3.2 M	\$4.2 M	\$2.7 M	\$2.6 M	\$2.6 M	\$2.7 M	\$1.8 M	\$2.2 M
Total	\$7.8 M	\$9.8 M	\$6.8 M	\$6.7 M	\$6.7 M	\$6.9 M	\$3.7 M	\$4.7 M

Table 2: Annual volumes of sand pumped from NSW in Queensland by TRESBP.

	m³
2001	575,869
2002	721,364
2003	787,026
2004	496,367
2005	724,931
2006	552,284
2007	562,247
2008	585,809
2009	409,232
2010	395,609
2011	518,169
2012	436,092
2013	319,883
2014	465,501
2015	552,682
Total	8,105,141



Point Danger and the Tweed River Entrance in 1935, before the Tweed River training walls were extended.



Point Danger and the Tweed River Entrance in 1967, shortly after the Tweed River training walls were extended.



Point Danger and the Tweed River Entrance in 2004, shortly after the bypass system was commissioned.

Figure 4: Historical changes to the Tweed River entrance. Source: Acworth and Lawson 2011, © NSW Department of Industry.

How was the project delivered?

The 1994 Heads of Agreement was formalised through legislation: the Tweed River Entrance Sand Bypassing Act 1995 (NSW) and the Tweed River Entrance Sand Bypassing Project Agreement Act 1998 (Queensland). The legislation apportions costs for the project as follows: 75% NSW and 25% Queensland for the design and construction phase, and 50% NSW and 50% Queensland for the operational phase.

The first stage, completed in 1998, was the dredging of 3,000,000 m³ of sand from the entrance to the Tweed River for the nourishment of southern Gold Coast beaches. The second stage, the construction and operation of a

permanent sand bypass system, became fully operational in May 2001. The project was designed and constructed by McConnell Dowell with finance provided by the ANZ banking group under a 24-year 'build, own, operate and transfer' contract with the state government partners (NSW Government 2001), a form of Public-Private Partnership.

The involvement of the private sector in the project was driven by a number of factors including; uncertain technology, innovative approach and the cross jurisdictional aspects which required independent operation. The use of a Public-Private Partnership allowed for the sharing of risk between the private partner and the government parties. This accommodated the variability in coastal processes in ways that could not have been managed with a traditional contracting approach.

What have the outcomes been?

The permanent sand bypass scheme comprises a system of pipes and outlets, a jetty and pumping station at Letitia Spit in NSW (see Figure 2 and Figure 3). The jetty is 450 m long and runs perpendicular to the shoreline supporting 10 sand pumps, which draw in a mixture of sand and water from the seabed. By pumping during southerly conditions, longshore transport feeds sand into the system. The sand and water mix is piped onshore along the jetty and transferred from the pumping station into a system of 400 mm-diameter steel pipes which run beneath the Tweed River to four outlets at Durranbah Beach, Snapper Rocks East, Snapper Rocks West and Kirra Point.

Between 2001 and 2015 the permanent system bypassed more than 8 million m³ of sand across the Tweed River entrance at a combined total cost to NSW and Queensland of \$121.7 million.

In re-establishing the longshore flow of sand from NSW into Queensland the TRESBP has contributed to reducing the vulnerability of southern Gold Coast beaches to erosion and to improving the safety of navigation at the Tweed River entrance. From a cost perspective, the sand supply to the southern Gold Coast provided by the TRESBP is \$14/m³ (over the 15 years of operations) which is comparable to the cost of offshore dredging. However, the TRESBP provides additional benefits in the form of improvements to navigation safety. Figure 4 provides a series of aerial photographs that show the impact of the various interventions in coastal processes at the mouth of the Tweed River.

Implications for climate change adaptation

Coastal managers faced with the challenge of adapting to climate change must consider not just the rising sea, but the response of shorelines to sea-level rise and, in some instances, to changing wind and wave conditions. These responses may have consequences in line with those that the southern Gold Coast experienced following the extension of the Tweed River training walls. In these situations, decision-makers will be faced with competing priorities, overlapping jurisdictions and incomplete institutional arrangements, all of which had to be addressed in reaching an agreement between NSW and Queensland Governments to develop the TRESBP.

The actions of Queensland Government and City of Gold Coast within the case study highlight the importance of identifying climate change adaptation options which work within existing knowledge and institutional constraints, while actively seeking to improve knowledge and preparing for the emergence of policy windows which allow for changes to institutional arrangements. This could be framed in terms of the relationship between incremental and transformational adaptation.

The actions of the NSW Department of Public Works highlight the consequences of interventions in coastal process but also how dealing with problems can also drive innovation and learning. In the same way that the Tweed River training wall extension led to decades of knowledge acquisition, projected impacts of climate change on the coastal zone are driving significant advancements in understanding of coastal processes. Just as at the Tweed River, these advances will improve the capacity to identify and implement management responses.

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Further reading

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New South Wales Government's website: <http://www.tweedsandbypass.nsw.gov.au> (accessed 15 June 2017).

A video on the Tweed River Entrance Sand Bypass Project: <https://www.youtube.com/watch?v=18Q8RLiLZEw> (accessed 15 June 2017).

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Australian Government

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