CASE STUDY: STABILISATION OF A RAPIDLY ERODING POINT USING AN INSITU-FILLED GEOTEXTILE CONTAINER GROYNE FIELD

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Munna Point is a premiere recreational beach in the Noosa River which has been maintained by regular nourishment for over 20 years. As longevity of each nourishment was less than 6 months, the long-term costs were high and efforts were eventually suspended resulting in loss of the beach. In an effort to reinstate the amenity and provide a more stable beach, a groyne field accompanied by nourishment was proposed. To provide a low-impact, low-risk and low-cost solution, the groynes were designed with a low crest using sand-filled geotextile containers. To achieve the design, containers and scour mattresses were filled in-situ using a dredge, which was an innovative application of a methodology typically adopted for much larger containers. The first 3 groynes have successfully been installed as part of the first stage and 12 months of monitoring subsequently undertaken. The groynes have clearly been effective at extending the longevity of the nourishment and the wider intertidal profile has remained very stable. The beach is now successfully enhancing the amenity of the community and experiencing a high level of usage.

Keywords: groyne; groin; geotextile; low-crested

INTRODUCTION

Site Description

Munna Point beach is located at the confluence of the Noosa River and Weyba Creek in Queensland, Australia (Figure 1). The beach is adjacent to the Noosa River Holiday Park, a premier camping, recreational and fishing point on the Noosa River foreshore and a recognized community asset listed in the State Heritage Register for social and cultural value in 2009. The beaches are highly visible and experience high recreational use.

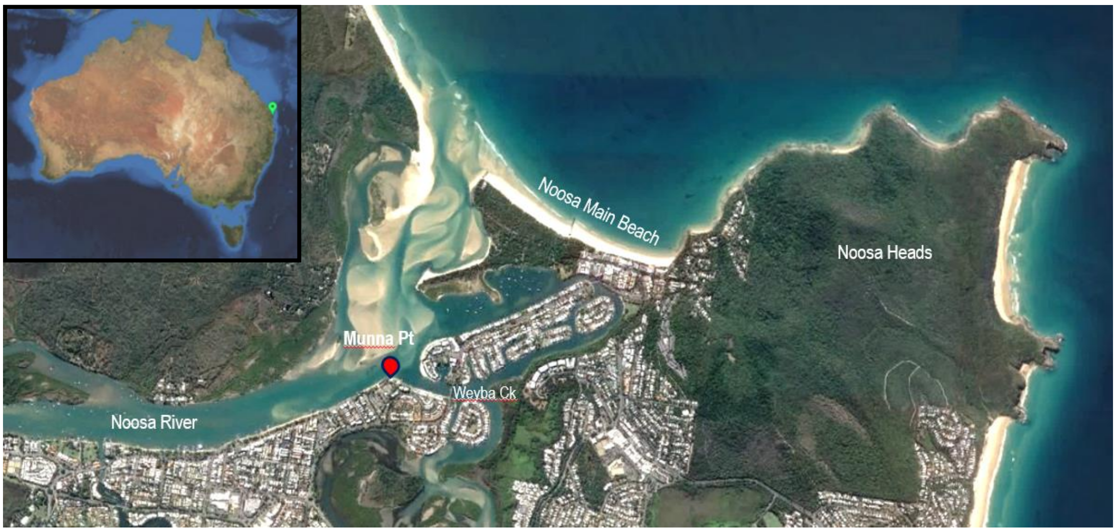

Figure 1. Location of Munna Point in the Noosa River and [inset] Noosa, Australia (Nearmap, 2015)

Site History

The site was reclaimed as part of a major development in 1974 and the relocation of the river mouth and reclamation of Noosa River Spit to protect this development was subsequently undertaken in 1978 (Corbett & Tomlinson, 2010 and Chamberlain et al, 2010). The Noosa River Holiday Park was established in 1983 (Figure 2).

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Erosion of Munna Point beaches was first observed in 1988. This was managed through bi-annual maintenance nourishment with volumes up to 5,000m^3. Nourishment longevity was reported to be typically less than 6 months, resulting in high maintenance costs (Figure 3). Nourishment volumes were reduced since 2001 and ultimately suspended in 2010 due to high long-term costs.

Nourishment was suspended, but erosion continued. In 2013, infrastructure was threatened and an emergency seawall approximately 1.5m in height was constructed using 0.75m^3 sand-filled geotextile containers (Figure 4).

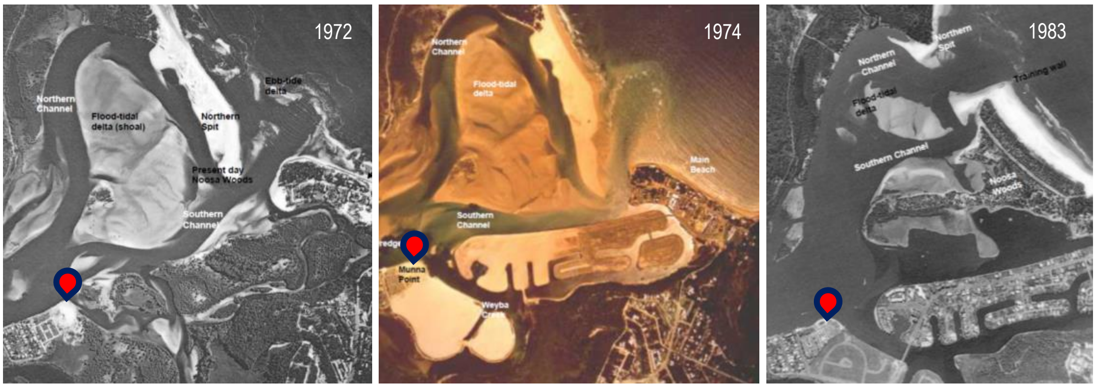

Figure 2. Historical Aerial Photographs from 1972, 1974 & 1983

Figure 3. Performance of Nourishment (left: post-nourishment Sept 2004; right: Jan 2006)

Figure 4. Emergency Seawall

WORKS

Design Objectives

At commencement of the project, there was no low tide beach adjacent to the emergency seawall and remaining sections of foreshore were narrow. Minor infrastructure and established vegetation were being threatened along sections of the foreshore not protected by the emergency seawall and the recreational amenity of the beaches were significantly diminished.

The objective of the project was to:

- Reinstate and stabilize wider beach
- Enhance amenity, beach accessibility and safety
- Low visual impact
- Low impact on coastal processes (including adjacent boat ramps and pontoons)
- Robust and able to accommodate natural variability
- Relatively low cost (capital & maintenance)

Design Concept

As such, beach nourishment was proposed with construction of a groyne field to stabilize the beach profile and extend the longevity of the placed nourishment. The groyne field included up to 8 groynes some 13 - 20m in length (Figure 5).

To minimise the visual impact of structures on the foreshore and retain the recreational amenity and accessibility of the beach, the structures were designed to be low-crested and constructed using softer, safer and more user-friendly sand-filled geotextile containers (Figure 15). Both $0.75m^3$ and $2.5m^3$ containers were utilized and all containers were fabricated using a non-woven needle punched composite geotextile for maximum durability (Heerten et al. 2001). Due to the proximity of the main channel and the high degree of natural variability of the Noosa River, a custom sand-filled scour mattress was specified to protect the toe of the structure and ensure that the structure remained robust and effective throughout its life.

The structure volume required was considerably lower than that for equivalent emergent structures and this realized considerable cost savings, as did the use of local sand for nourishment and sand fill.

Sand-filled geotextile containers result in flexible structures which can accommodate some movement without failure (Jackson et al, 2006). They can also be reconfigured, raised or lengthened to optimise performance. Should it prove necessary, they can be shortened or removed relatively easily. As such, with a comprehensive monitoring program, the works present a relatively low risk while providing a relatively robust solution in a dynamic and complex river system.

Stage 1 of the works included the construction of 3 groynes and was undertaken as a proof of concept and to inform the detailed design of the subsequent stages.

Figure 5. Design Concept

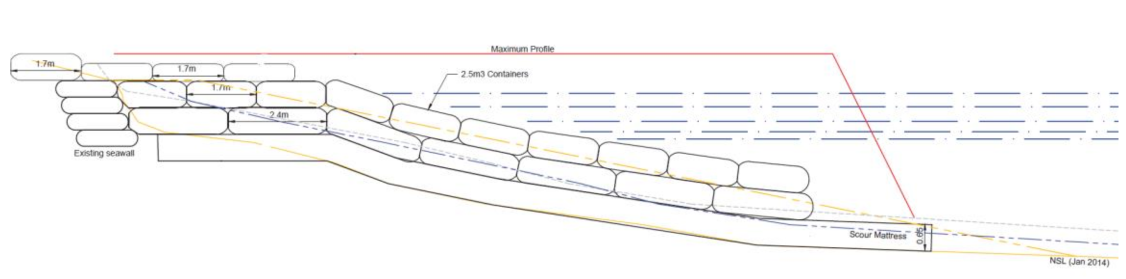

Figure 6. Typical Groyne Profile adjacent to seawall

Construction Method

Traditionally in Australia, sand-filled geotextile containers of this size are filled in a hopper and placed with a large excavator from shore (Figure 7) (Restall et al, 2001). This construction method would have been difficult for this design as the lower crest and length of the groyne would have required a reach beyond that of excavators typically used, even at low tides.

Figure 7. Traditional Method of Filling Sand-Filled Geotextile Containers

Construction of the first stage was undertaken in August 2015. The construction methodology involved the placing of pre-fabricated and pre-connected containers in the correct position and alignment with in-situ filling of both geotextile containers and scour mattresses using a small 6/4" dredge with a splitter box (Figure 8). This technique is more typical for larger mega-containers and its innovative application to the custom scour mattresses and smaller containers proved to be very successful provided containers were manipulated during the filling process to ensure adequate container shape and interlocking.

The same methodology was utilized for above water and underwater construction. As the depths were typically reasonably shallow, the need for commercial divers was limited to the closing of deeper ports of the scour mattress. This also resulted in cost savings compared with typical underwater construction activities.

An 8t excavator assisted with the loading and setout of the scour mattresses as well as manipulation of upper containers during filling as required. The minimal use of heavy construction equipment resulted in a safer and quieter work site which was of great benefit to the continued operation of the Noosa River Holiday Park.

The completed works were successfully completed (Figure 9) and were relatively low profile even prior to nourishment resulting in burial of the works.

Figure 8. Novel Method of Filling Sand-Filled Geotextile Containers In-Situ

Figure 9. Completed Stage 1 Groyne

MONITORING

A comprehensive monitoring program including regular survey by Noosa Shire Council and analysis (Corbett et al, 2017) has been implemented to evaluate performance of the works and inform the final design of the remainder of the groyne field. Ongoing monitoring is intended to continue as Stage 2 is implemented.

Section Stabilised with Groynes (Stage 1)

Review of survey data within the footprint of the Stage 1 works over a 14 month period (Figure 10 and Figure 11) indicates that the mid to high tide beach is 3 – 4m wider and the whole profile is 9 – 12m^3/m larger than the pre-construction condition. The intertidal nourished profile experienced some minor reprofiling as expected (<1m^3/m change) in the first 5 months but has since remained essentially stable. Observed widening of the profile below low tide could be the result of natural processes or the migration of nourishment downstream of the groyne field (which was not stabilized).

The planform shape of the beach is generally consistent with bi-directional sediment transport and a nett upstream (Westerly) sediment transport direction. The observable "groyne effect" is limited by the bi-directional nature of the sediment transport, the relatively narrow design beach width and the low-crested nature of the groynes which allow overpassing. At the groynes themselves, this is characterised by up to 2m difference in beach width and up to 0.2m difference in beach height (Figure 12).

Figure 10. Monitoring Survey showing Transect Location and Planform Shape of the Beach at Mid Tide (top) and High Tide (bottom)

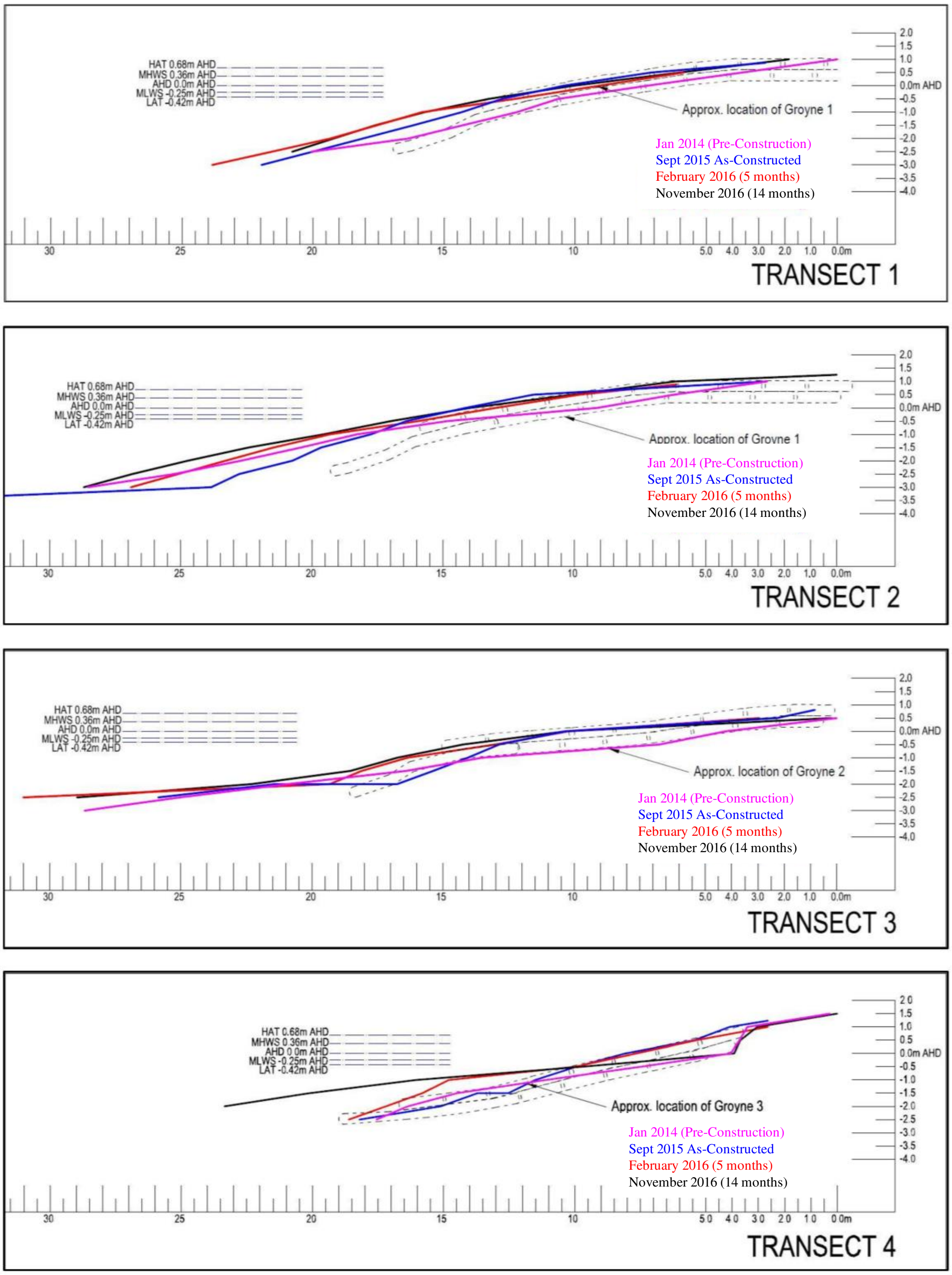

Figure 11. Comparison of Monitoring Surveys showing Beach Profiles at Relevant Transects. Location of Transects shown in Figure 10.

Figure 12. Photos showing up to 2m change in beach width and up to 0.2m change in beach height at Groyne

Section without Groynes

As part of Stage 1, the remainder of the foreshore was nourished without the construction of stabilising groynes. In this area, the beach width rapidly reduced and the seawall was once again exposed. Furthest from the Stage 1 works, the beach was completely lost within 5 months, consistent with the longevity of previous nourishment campaigns. Closest to the Stage 1 works, the beach benefited from the effect of the adjacent groynes and after 5 months a 25-30m length of beach remained. Due to the bi-directional nature of the sediment transport, the length of the stabilized foreshore was gradually reduced to <10m after 14 months (Figure 13).

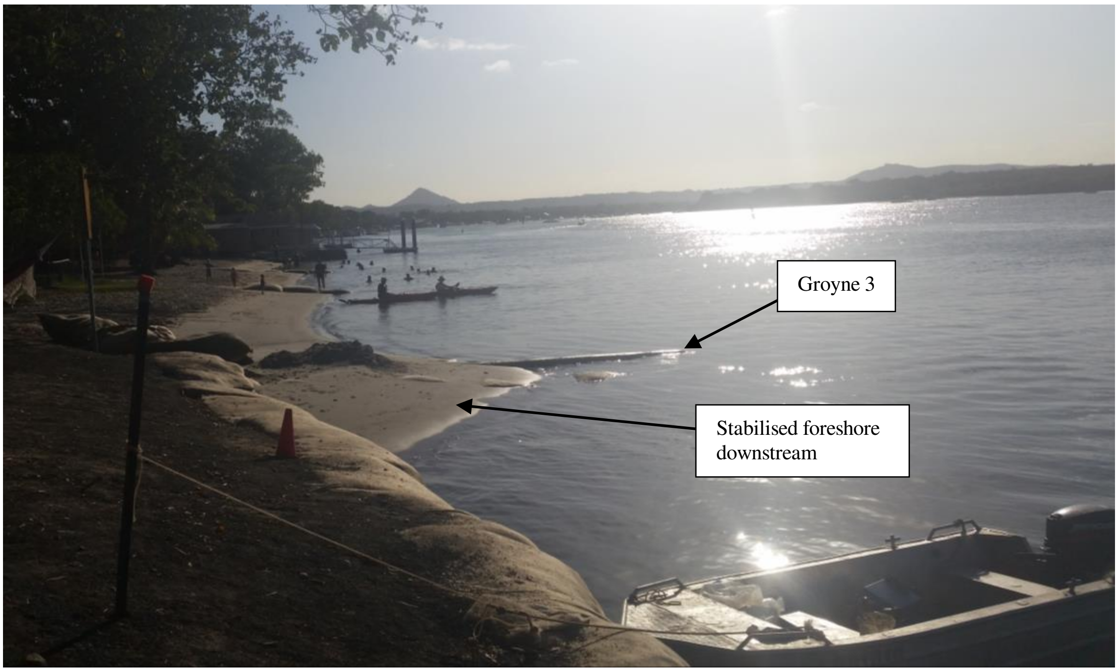

Figure 13. Photo of slight mid-tide groyne effect north of Groyne 3 after 17 months

Amenity

Since construction, the structures have remained predominantly buried. As such, they remain very low impact visually. Recent inspection of the beaches (Figure 14) indicates that the beaches have been very busy and support a wide range of recreational usage including swimming, fishing and boating. As the groynes are soft and only slightly extend above the beach profile, accessibility across and along the foreshore is safe and essentially unimpeded. The groynes are not creating any dangerous currents or eddies.

Coastal Processes

The groynes are not stabilizing an excessively wide beach. The structures are largely buried and clearly allow overpassing, so impacts on longshore sediment transport are expected to be reasonably limited. The works should be capable of accommodating changes to prevailing conditions as a result of natural variability of the system, however this will be better evaluated in the longer term.

Some maintenance profiling of the boat ramp may be necessary, although this may be addressed by the implementation of Stage 2. Impacts on adjacent pontoons are not expected until Stage 2.

Cost

The capital costs of the structures were significantly lower than traditional materials such as rocks and for alternate designs including emergent groynes for which larger volumes of materials are required. The maintenance requirements to date have been minimal and the potential for vandalism is lower for structures which are largely buried although sand-filled geotextile containers can be vulnerable to vandalism and this should be assessed in the longer term.

Environmental

While environmental concerns are not an objective of the project, sand-filled geotextile containers are known to promote marine growth (Jackson et al 2004 and Corbett et al. 2010) and this project has been no exception. Where containers are exposed, algaes were observed to establish within days of placement and over time have developed into a range of macroalgae species (Figure 15). The works also support a number of fish, stingrays and crabs as well as being friendly to birds.

Figure 14. Beach Usage and Low Visual Impact after construction of Stage 1

Figure 15. Environmental Outcomes from using sand-filled geotextile containers

CONCLUSIONS

The Stage 1 constructed groyne field appears to have effectively stabilized a wider upper beach over at least a 14 month period. As sections of nourished foreshore not stabilized by groynes experienced a complete loss of the nourished material within 5 months, it is clear that the stability of the beach has been improved and the longevity of the nourishment has been extended by the works.

The re-established beach is experiencing a high level of usage and community response has been very positive. Monitoring is ongoing, but there does not appear to be any major issues identified.

The second stage of the project is presently being implemented.

ACKNOWLEDGEMENTS

Concept and detailed design, construction supervision and monitoring was undertaken by International Coastal Management in conjunction with Noosa Shire Council. Construction methodology was developed and refined by local contractor Nabis Dredging using custom geotextile containers developed by Geofabrics Australia.

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