**THE ROBIN HOOD APPROACH TO COASTAL MANAGEMENT - SAND HAVESTING THROUGH THE EYES OF BEACH SCRAPOLOGISTS**

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INTRODUCTION

Beach scraping or as originally and perhaps more appropriately described “Nature Assisted” Beach Enhancement (NABE), remains a somewhat poorly understood concept in Australia (Gordon 2015) and is often overlooked as a legitimate approach for coastal management. NABE is best suited to manage a situation where there is a need to rapidly restore a beach following an erosion event, or where a beach is suffering short to medium term recession, and there is a natural bypassing sand resource in the littoral zone that can be effectively “harvested” to establish or increase a dune sand buffer to protect built assets. The paper discusses both aspects but will focus on the latter, to provide a review of the overall viability of NABE in the context of sand harvesting operations at two NSW locations, where NABE operations have been integral in ensuring both the short and medium-term coastal security.

THE MECHANICS OF NABE

NABE has traditionally been considered a methodology for accelerating the natural process of returning sand to the subaerial beach and dunes in response to the impacts of storm erosion (Carley *et al* 2010, Gordon 2015). This same approach can also be applied in the context of a sand harvesting operation, where littoral drift sand is captured and repurposed to augment natural sand buffers and reduce threats to beachfront assets and infrastructure from processes of coastal erosion, recession, and inundation. That is a NABE approach is essentially used to borrow from a relatively “rich” littoral drift supply to supplement and build the dune buffer.

Notwithstanding the subtle differences in these objectives, the mechanics associated with the NABE procedure are fundamentally the same, with sand harvested from the swash zone through mechanical means, moved up the berm and to the back of the beach to build the incipient dune (Figure 1). Natural resupply facilitated through littoral drift and onshore supply to the swash zone then occurs, often surprisingly rapidly, over the course of the next tidal cycle, after which the NABE procedure can essentially be repeated.

In the case of beach recovery, the principal focus of the NABE operation is to speed up the berm and foredune recovery process following an erosion event and re-establish the width of the recreation beach. The mechanical and physical processes which underpin this type of operation are explored in Gordon (2015). Through this NABE approach, the recovery of a beach can be accelerated to a matter of weeks, rather than months (if not years), as may be the case following a major erosion event, or a series of storms in succession.

On the littoral drift coastline of the northern NSW coast, in some locations where assets have become increasingly threatened by erosion and recession, NABE operations have instead been used to bolster back beach sand reserves, carried out in periods when the beach is in an accreted state. This type of application has successfully allowed sand volumes, over and above what would typically be expected as part of a natural recovery cycle, to be harvested and added to the existing foredune, thereby building the overall dune volume of sand which is then available to act as buffer to assist in protecting threatened assets from future erosion events.

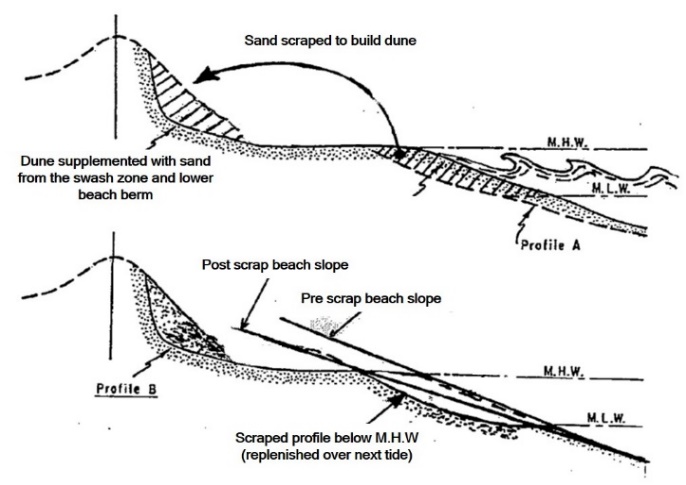


Figure 1 – Beach Scraping Concept. Modified from Carley *et al* (2010)

EQUIPMENT

Prior to undertaking a NABE campaign, careful consideration should be given to procedure, machinery options and size, including that which is readily available for the operation. In this regard, it helpful to consider the beach in terms of three distinct zone in which the material will need to be worked from and transported to.

The swash or intertidal zone represents the key area from which sand is to be harvested or “won”. This intertidal sand is best harvested through a long reach or standard excavator. A standard excavator will suffice but will likely spend more time experiencing wave wash. Conversely, a long-reach excavator will allow for sand to be harvested further seaward, though the tradeoff will be an often-smaller bucket size and thus a smaller volume per load than a standard excavator. The use of multiple excavators can also speed up this operation. Harvested sand is moved from the swash zone and temporarily deposited on to the dry berm, to be progressively worked up the beach as the tide rises. This methodology enables the sand and water mix from the bucket to naturally de-water.

Though working of the swash zone can also be accomplished with a (bull)dozer, a dozer will be more restricted to working in this zone around the lowest part of the tide. A dozer is also more vulnerable to damage from saltwater inundation and hence is limited in how far seaward sand can be won. Standard dozers can more easily become bogged in soft sand which can have a catastrophic outcome if it occurs at low tide and the machine is subsequently inundated. Therefore, if using a dozer in the swash zone a “swampy” (wide track) dozer is preferable along with a backup machine to help free any bogged unit.

The middle beach represents the transition zone where sand is initially stockpiled and progressively moved towards the back of the beach to replenish or build the incipient dune. As the sand is moved by the excavator, it is stockpiled in a temporary windrow at a suitable distance above the incoming tide, before again being worked to the back of the beach. The deployment of a dozer on the berm has been found to be highly beneficial, allowing it to work in concert with the swash zone harvesting operation and significantly improve the speed of the operation. Even a small dozer can move relatively large volumes of material landward on the berm with greater efficiency than an excavator.

The final operational phase involves building the incipient dune. Previous harvesting campaigns have found this to be best accomplished through a combined dozer and excavator setup. The dozer again permitting a larger volume of sand to be more efficiently moved, with the excavator allowing for a more nuanced placement. In the cases of the examples below, a combination of a two excavator, one standard and one long-arm and a dozer (preferability a D7 or larger), combined with a smaller unit like a Posi-track to finesse the shaping of the dune, was found to provide the greatest flexibility.

Importantly, once the dune is formed it is desirable, as soon as practical, to construct sand catching fences and introducing dune stabilizing plants, preferably native to the area, to minimise uncontrolled loses of sand due to wind action into, or onto, the back of beach assets that were to be protected. It is therefore advisable to have the necessary equipment and a store of plants readily available on-site before the NABE project is finalised.

NEW BRIGHTON

New Brighton is a low-lying coastal village situated approximately 1 km north of the Brunswick Estuary. New Brighton is typical of a northern NSW drift aligned beach, nestled with the broader Cape Byron to Hastings Point sediment compartment. The littoral transport rate is estimated to vary between 120,000m3/yr and potentially up to as high as 500,000m3/yr, subject to influences of prevailing wave direction and power, beach rotation and broader climatic cycles.

New Brighton has a long history of coastal erosion events superimposed over an underlying trend of long-term shoreline recession, with the village area reliant on the on-going presence of dunes for coastal protection. In the 1970s, a series of major cyclones and storms devastated the village of Sheltering Palms to the immediate south of New Brighton and removed the dunes protecting New Brighton itself. As a result, in the late 1970s the village of Sheltering Palms and some of the allotments at the southern end of New Brighton were purchased by the State Government and returned to a “natural” state by the then NSW Public Works Department. This was achieved through a NABE approach, scraping sand from the beach berm and swash zone to construct dunes over the former Sheltering Palms village and in front of the New Brighton village area.

Throughout the 1980s and 90s, following major erosion events NABE campaigns have been repeatedly used at New Brighton to assist with beach recovery and bolster the dunes fronting the village. More recently, campaigns have been undertaken in 2010, 2013 and 2017. The two earlier campaigns were undertaken following erosion events, whereas the most recent sand harvesting operation was undertaken on an accreted beach profile.

The 2017 NABE campaign covered a longshore extent of approximately 1.5km, adjacent to the village area. Operations were conducted across a three-week period and selected to align with the spring tides, to maximise the time and extent of the swash zone able to be harvested across the lowest part of the tidal cycle. The operations focused on achieving a nominal scrape depth of 0.2m – 0.3m, acknowledging operator inconsistency. This limited scrape depth accords with recommendations provided in Gordon (2015) and the notion of “responsible scraping” (Bruun, 1983). Its noted here that any deeper swash zone excavations may inadvertently expose the upper beach and dune to increased risk of wave attack during the high tide cycle, which would be counterproductive to the purpose of the NABE operation and thus should be avoided. Gordon (2015) also suggests by limiting swash scraping to approximately 0.2m, best opportunity is afforded for the swash zone to recover before the next tide.

Pre and Post NABE surveys yielded a total sediment fill of 14,363m3, enhancing the back beach dune buffer. Across the longshore extent, this resulted in a 10m3/m (averaged) sediment yield, though a number of single profile transects indicated yields of up to 15m3/m, where the presented working conditions were more favourable and hence a larger scraped volume was able to be harvested. A revegetation management plan was implemented post NABE, which included seeding for Spinifex, planting of ground species and fertilizing. Several beach accessways were also re-established over the newly formed and higher dune, with extra fencing built north and south of each accessway to limit public access to the dune and assist with stabilization.

Two additional surveys were completed at approximately 4- and 8-months post scrap. At the 4-month interval some losses of sand were recorded, principally owing to several swell events that occurred during this period. At the 8-month survey these losses had recovered and further bolstered by additional (natural) supply. The sand was

also found to have moved further landward into the hind dune area owing to wind action. This was a further positive outcome in ensuring additional longevity and protection from future storm events and recession.

WOOLI

Wooli is a small coastal village located in Northern NSW. The township is sited on a narrow peninsula, bounded to the west by the Wooli Wooli River and to the east the Pacific Ocean. Similar to New Brighton, Wooli has a long history of coastal erosion and recession, with reports indicating the beach has receded up to 35m over the last half a century and threatening public and private assets.

Wooli beach is considered a hybrid between a drift aligned and embayed beach, with headline, offshore reefs and breakwaters extending from the Wooli Wooli river providing some degree of wave refraction and diffraction (RHDHV, 2001), but also an underlying northerly littoral drift component estimated to be in the vicinity of 75,000m3/yr – 100,000 m3/yr.

Following the completion of Wooli Coastal Zone Management Plan, a beach management strategy was developed to manage the erosion and recession risk for Wooli. This involved a ‘work with nature’ approach, where a portion of the littoral drift sand, which would otherwise bypass the beach is harvested in order establish and build incipient dune volumes and offset future storm demand.

2019 marked an important milestone for Wooli, which saw the implementation of the first sand harvesting campaign. The operation involved two passes, the first was completed across seven days in April, and the second in May across five days. The four week break between campaigns was due to an erosion cell which moved through the compartment. Had this erosion cell not occurred, the passes would have been undertaken back-to-back.

The campaign focused on the most at-risk area of the shoreline spanning 800m adjacent to the village area. In the swash zone, a 0.2 – 0.3m scrape depth was again targeted to maximise the operational efficiency without impacting on the viability for recovery in the borrow zone. Observational evidence indicated a full recovery of the swash zone across a single tidal cycle, with the profile for the borrow areas indistinguishable from those adjacent at the next low tide.

Pre and Post volume surveys yielded a total fill volume of 13,596m3, which equates to 15-17m3/m (Figure 2). Detailed integration of survey volumes indicated yields of up to 30m3/m across some profiles. This higher yield was likely the result additional sediment being mechanically supplied from the neighboring area(s) to fill previously lowered and storm cut parts of the profile. Following the operation, a concerted dune revegetation program was also undertaken, along with the installation of sand catching fencing. This was considered an integral part of the operation in assisting to stabilise the newly established dune and prevent windblown losses of sand and/or the potential formation of blowouts.



Figure 2 – Wooli Pre-Post profile survey indicating scraped volume won (shaded orange), from the initial profile (blue line) and postscrape profile (green line).

The costs of NABE are relatively modest on a per m3/m volume cost. Costing for the Wooli campaign was circa $80,000, inclusive of design and operations, which equates to ~$6m3/m, with an additional $20,000 allocated for dune fencing for revegetation. These costs also accord with NABE estimates provided in Carley *et al* (2010) and is well below general industry costs for sand nourishment, which typically can range anywhere between $10m3/m - $75m3/m depending on the sand source, extraction method and transportation distances.

Similar to New Brighton, the works are considered to be highly successful and effective in providing interim protection to Wooli and expected to provide protection up to an 1:20 ARI storm event. Following on from the initial operation, an additional NABE campaign is schedule in 2022. The aim is to build on this work through additional sand harvesting from the littoral drift system to continue build sand reserves to try and achieve protection against an up to 1:50 ARI storm event.

CONCLUSIONS

Beach NABE has proven to be a practical short to medium-term management tool to rapidly re-establish beach berms and dune systems following erosion events. Explored here is also its application from a sand harvesting perspective, which can be readily utilised on littoral drift coasts. As demonstrated at both New Brighton and Wooli, this has proven to be a highly effective low-cost coastal management strategy for bolstering dune system and increasing sand buffers in order to protect otherwise at-risk assets from erosion and recession hazards and thus ensuring coastal security.

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