OPTIONS FOR STABILISING RIPARIAN ESTUARINE ZONES

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Key Points

- Options to traditional revetment for stabilising eroding estuarine riparian zones do exist and should be considered to allow for greater estuarine habitat re-establishment or maintenance.
- Rock fillets, saltmarsh benches, stable grade beaches and log crib walls represent options to consider.
- Identification of the preferred option will be site specific and depend on biological and hydraulic behaviour and constraints.

Abstract

This paper deals with the issues and practical considerations of providing stability to eroding river banks located in estuarine settings. The adaptation in recent years of traditional 'hard engineering' solutions in order to provide increases in habitat and environmental values, has led to a range of options being trialled and adopted.

The Soil Conservation Service (SCS) has been involved with the design and implementation of these options in the Hunter and Wallis Lakes catchments including rock fillets, saltmarsh benches, stable grade beaches and log crib walls. An evaluation of the effectiveness of these solutions in comparison with traditional rock revetment has been made with conclusions based on pre-determined goals of stability and post construction mangrove and saltmarsh recruitment.

The function and application of these options has also been assessed based on:

- Desired outcome – stability, revegetation or both?
- Function over time – will structure dilapidation reduce function or is there inherent resilience?;
- Monitoring and evaluation.

The successful implementation of the options discussed has also been considered and is dependent on adequate site survey, an attention to detail during construction and identifying outcome(s) of proposed works

Introduction

The move towards riparian restoration projects which are less engineered and adopt channel stability principles exhibited in natural stable systems has been a constant endeavour by river managers. This approach has also applied in estuarine riparian zones however with a less documented focus compared to their freshwater cousins.

The Soil Conservation Service (SCS), in partnership with Newcastle City Council, Great Lakes Council, Department of Fisheries and Local Land Services, has designed and constructed a number of options for estuarine bank stabilisation from 2009 to

present. Both the SCS and its partners see the value in evaluating and reviewing the outcomes of these projects to inform future projects. The following options are discussed detailing their effectiveness, practical construction considerations and short to medium term condition and behaviour.

Rock Fillets

In NSW, these bank stabilisation structures were pioneered by Rivercare staff Rick James and Simon Skelton who in the late 1990's who undertook a successful trial along the Manning River at Dumaresq Island north of Taree. These structure types provided a viable option to traditional rock revetment (rip-rap) which had limited capacity to allow for riparian vegetation to establish once installed.

Rock fillets are pyramidal rock structures typically constructed to mean high water level or above and installed 2-4m from the edge of eroding banks parallel to flows with an opening at their downstream extent to allow for passage of aquatic flora and fauna. Their height allows for wave energy dissipation, low energy near bank flow zones and resultant deposition of sediments, and subsequent natural recruitment of mangroves in between the structure and eroding banks. Long term bank stability has been established as a result.

Other stakeholders have since adopted this technique in bank stabilisation projects constructed by the SCS which are reviewed and discussed in this paper. These include:

Wallamba River, Darawank. 1000m of rock fillets installed for Great Lake Council, 2009

Hunter River, Stockton. 150m of rock fillets installed for Newcastle City Council, 2010

Hunter River, Scott's Point. 1750m of rock fillets installed for Department of Fisheries, 2011

The observations over time at these sites - from construction to present - allow us to determine that rock fillets play a successful role in facilitating near bank mangrove regrowth. The effects of this combined with the wave (wind and boat wake) energy dissipation function of the fillets can significantly reduce the rate of bank erosion.

Where mangrove recruitment is significantly less there is an observed correlation with the type of sediment which is being deposited behind fillets. Successful mangrove recruitment is dependent upon deposition of fine-grained deposits such as mud/silt. Coarse-grained depositions such as sand result in reduced uptake. This was identified during the trial construction of 150m of rock fillets for Newcastle City Council at Stockton in 2010 where the majority of deposited material was coarse-grained sand. The present day mangrove recruitment rates at this site do not differ from that occurring outside and adjacent to the trial fillets with some fillets showing zero mangrove plants.

Another recorded observation, which requires more detail research, is that the successful sites (Manning River, Wallamba River and Hunter River-Scott's Point) exhibit mostly mud/silt deposits. At Stockton the main source of coarse grained sand is from the adjacent bank/floodplain which is a man-made fill structure consisting of sand

and historical ship rock-ballast. Further research would allow for determination of the origin of rock fillet sediment deposits and whether they are contributed from floodwaters or eroding banks and if the latter, whether ongoing bank erosion post construction is a key to the success of mangrove recruitment.

The short to medium term observations on fillets constructed at all of the sites indicate that erosion is not completely halted by the combined effects of wave dissipation and mangrove recruitment. At Scott's Point this ongoing erosion has been observed to facilitate natural regrowth of other tidal vegetation assemblages in addition to mangroves. As the bank erosion continues behind the fillet where mangroves have already established, the eroded material contributes to that which has already deposited. The combined deposited material creates a graded cross-sectional batter which, if the erosion continues, can result in a uniform batter from the inside of the fillet to the top of the bank.

This naturally graded batter, exhibiting a range of tidal levels, presently allows for mangrove, saltmarsh (*Triglochin striata* and *Suaeda australis*) and terrestrial species (White Cedar and She-Oak) to establish. The occurrence of this process and resultant increased species diversity due to fillet construction, begs the question whether this graded profile should be considered at the design stage and incorporated into future fillet constructions.

Alternative fillet construction trials were also conducted as part of the Hunter River, Scott's Point project. This involved construction of fillets that were significantly lower than the standard Mean High Water (MHW) or above. A 100m section of rock fillets was installed that extended 300mm (not the typical 1000-1200mm) above the construction bench. The location of the 100m trial site was chosen as there was an existing population of juvenile mangroves that were at risk as erosion had resulted in their root networks being exposed to a depth of 300mm. This root exposure depth dictated the height of the trial fillets. Observations of this site presently indicate that mud/silt has deposited to a depth of 300mm, level with the top of the fillet, resulting in the root networks being covered over and the mangroves continuing to grow to maturity since the trail was adopted in 2011.

Additional low fillet trial sites undertaken on Scott's Point by the SCS have also proved successful indicating that these structures should be considered at the design stage and may offer a less expensive, quicker to build option that are potentially more resilient in high flows.

Saltmarsh Benches

As previously discussed, poor mangrove recruitment has been observed at the rock fillets constructed on the Hunter River, Stockton in 2010. This trial site determined that the remainder of NCC prioritised stabilisation reaches would not benefit from rock fillets. Alternative options to full rock revetment were considered with NCC contracting the SCS to design and construct a trial saltmarsh bench to be incorporated into a standard rock revetment design.

The SCS conducted surveys of the nearest stable populations of saltmarsh which were located 3km upstream on the Hunter River at Stockton Sandspit (Hunter Wetlands NP).

Surveys were primarily conducted to determine the tidal range at which saltmarsh optimally occurs with surveys indicating existing populations occur within a narrow 300mm range. These levels were then transferred to an NCC prioritised bank location 3km downstream. Once it was determined that these levels could be practically duplicated and incorporated into a rock revetment structure- design and construction of a trial 200m long x 1.2m wide x 0.3m deep saltmarsh bench took place in 2014.

The saltmarsh bench was manually planted with saltmarsh species by NCC immediately after construction. Monitoring of the site by SCS and NCC indicated that the saltmarsh plantings continued to successfully colonise the bench with 100% ground coverage achieved in 12 months. An additional 150m saltmarsh bench was trialled upstream in 2016, approximately 1.5km from the Stockton Sandspit population. Site constraints such as remnants of a heritage wall along the eroding foreshore dictated that the saltmarsh bench be constructed at the upper limit of optimal tidal range.

The initial saltmarsh plantings undertaken by NCC did not survive indicating that the optimal tidal range for establishment of the saltmarsh population had been exceeded. Recent monitoring of the site in October 2017 however showed that the bench had subsequently been colonised, by way of natural recruitment, by *Sarcocornia quinqueflora* and *Sporobolus virginicus* – two main species of a Saltmarsh population

Stable Grade Beaches

In 2014 Hunter Local Land Services (LLS) requested a stabilisation design from the SCS for a 850m long eroding section of the Hunter River, South Arm on Ash Island located in the Hunter Wetlands National Park. Site surveys indicated that the majority of the design reach comprised a 0.5-1.0m high actively eroding bank profile with 2 distinct stable reaches approximately 30m in length. Cross-sectional surveys indicated that the stability had been provided by the bank erosion retreating into the floodplain resulting in recurring sand beaches approximately 12-15m in length with typical grades of 1:10. These sand beach grades thus illustrate a stable equilibrium between erosion potential from waves and energy dissipation along the cross section. In addition to the stability occurring in these locations, the grade has allowed for a range of tide levels in which mangrove, saltmarsh and terrestrial species exist.

The design process therefore adopted, where physically possible with respect to adjacent road infrastructure, formation of these stable beach grades by way of earthworks. Construction works are yet to commence on these design sections however the intention is to replicate this stable grade beach along an entire reach with LLS to undertake plantings of saltmarsh and terrestrial species.

Log Crib Walls

The long term resilience of rock fillets is yet to be tested owing to them being a relatively new bank stabilisation technique. Monitoring of both Scott's Point and Wallamba River structures indicates that adjustment has occurred to small sections of the fillet structures. On the Wallamba River, on a small 5m long section of a fillet, the integrity of the structure had been reduced as a result of water drawing through a

porous opening in the rock work. Over time since construction in 2009 this led to this section of the wall failing and being washed away. The resultant 'gap' in the fillet has led to this section suffering from active erosion similar to that which was occurring before the fillet was constructed. This 5m wide eroding section of the riverbank was in distinct contrast to the adjacent banks which are being provided stability by both the intact fillet and 4m high, 8 year old mangroves. Whilst a definite success on a whole – this eroding section clearly highlights the risk to established mangroves if the fillets fail.

On Scott's Point a similar process had occurred on one fillet with a similar outcome. Additionally the deposited material that accrues behind fillets is dependent upon the outside revetment function of the fillet to remain insitu. When over time the fillet degrades, which is inevitable unless maintenance work is undertaken, the ability of the deposited material to not be eroded away will be dependent upon the erosion control properties of the established mangroves relative to their age and stability afforded. As such they are at higher risk to failure over time.

Questions as to the long term resilience to floods as well as cost of rock fillets, and the success of low rock fillets, led the SCS to identify if alternatives could be designed. With this in mind the SCS has designed a low (in similar height to a low rock fillet ie 300-500mm) log crib wall for the LLS to be constructed on the Williams River, Raymond Terrace in early 2018.

The premise of the structure is that over time there will be movement and settling of the log components due to flood and tidal flows. The log components will comprise not only trunks and rootballs, typical of freshwater Large Woody Debris (LWD) in-stream structures, but also thicker branches that will be intertwined as part of construction. As the timber components settle over time the intertwining nature will reduce potential for mass failure and allow for timber to embed and strengthen - not unlike natural bank-attached LWD. These timber assemblages therefore aim to dissipate energy, deposit sediment and allow for mangrove regrowth similar to rock fillets but have inherent resilience over time.

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