CASE STUDY

Proposed Measures for Enhancement of Amenity Beaches, Newcastle, Co Down

ABSTRACT:
There is a widespread perception of beach erosion at Newcastle that has prompted initiatives to improve the current amenity beach resource. Analysis of historical records of beach and shoreline status, coupled with numerical modelling of wave energy in the nearshore under contemporary and historical bathymetries, permits an analysis of the causes of the perceived deterioration in the beaches. Such analysis is essential for the design of 'remedial' measures and is outlined in this report.

LOCATION:
Newcastle, County Down – Northern Ireland

KEYWORDS: *Beach morphology and evolution, Economics, Beach Management in Practice*

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EXECUTIVE SUMMARY

The entire shore of outer Dundrum Bay is fronted by a wide, low gradient, intertidal beach characterised by a sequence of ridges and runnels that overlie a gravely basement that is periodically exposed and covered by sand. The thickness of sand cover is variable (from a few cm to over 1m). The rear of this intertidal beach is backed by a steep, high tide beach composed of sand, pebbles or a mixture of the two.

Since 1861 a considerable volume of sand has accumulated in the nearshore area of Dundrum Bay (Navas 1999). This has had the effect of enhancing northward littoral drift of sand within Dundrum Outer Bay. Wave simulations (Navas, 1999) show that the drift is northeastward in all sections of the high tide beach but that a small drift reversal occurs in the vicinity of the Shimna River outlet. In this drift reversal area sand is transported to the southwest. Simulations indicate that potential cross-shore sand transport is directed onshore at high tide but that it is an order of magnitude lower than the potential longshore transport volume. Given this situation, a retardation of the longshore transport by the construction of groynes may cause retention of the cross-shore transported sand and thus promote accretion of the high tide beach.

Monitoring and interpretation at monthly intervals should be done in conjunction with the implementing body (Down District Council) and the construction contractor. Monthly monitoring, calculation of trends and advice on groyne installation is likely to cost in the region of £40.000.

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1. Introduction

There is a widespread perception of beach erosion at Newcastle that has prompted initiatives to improve the current amenity beach resource. Analysis of historical records of beach and shoreline status, coupled with numerical modelling of wave energy in the nearshore under contemporary and historical bathymetries, permits an analysis of the causes of the perceived deterioration in the beaches. Such analysis is essential for the design of 'remedial' measures and is outlined in this report.
A previous report identified the nature of the perceived problem and presented four potential strategies. Of these, the construction of groynes to enhance beach volumes was preferred by Council. This option is thus elaborated in this report and a scheme is presented for emplacement of a series of groynes.
This report outlines the mature of existing beaches at Newcastle and provides a situation analysis that interprets the present beaches in terms of past changes in the shoreline. On the basis of this understanding, a design is presented for a trail series of groynes as a measure to enhance the quality of existing recreational beaches at Newcastle. A monitoring plan is outlined to accompany the trail emplacement and likely costs are estimated.

2. Contemporary beach morphology

The entire shore of outer Dundrum Bay is fronted by a wide, low gradient, intertidal beach characterised by a sequence of ridges and runnels that overlie a gravely basement that is periodically exposed and covered by sand. The thickness of sand cover is variable (from a few cm to over 1m). The rear of this intertidal beach is backed by a steep, high tide beach composed of sand, pebbles or a mixture of the two. At present, three such area of high intertidal/supratidal beach exist along the Newcastle beach front. The most southerly extends from the mouth of the Glen River to the south end of the Newcastle Centre and is composed of sand with variable amounts of gravel. The beach is backed by a promenade and recreational lands. It is narrowest in the south and widens northward to the Newcastle Centre. The high tide beach is interrupted by the Newcastle Centre.
A second high tide beach extends from the north side of the Newcastle Centre to the mouth of the Shimna River and is composed almost entirely of sand. Several concrete groynes in bad repair are present on this section of the beach. North of the Shimna River as far as the car park adjacent to Slieve Donard Hotel, is a third narrow beach of sand and gravel backed by a promenade (Downs Park). Toward the south of this beach a few wire-bound gabbions have been fashioned into groynes at the outlet of the Shimna River but these are now badly decayed. North of the car park the high tie beach is better developed in front of the Slieve Donard Hotel and beyond. Several groyne remnants are present in front of the Slieve Donard Hotel and the Royal County Down Golf Club. The intertidal beach is largely sandy except in the area fronting the Slieve Donard Hotel and Downs Park where it is persistently gravely (see below).

3. Situation Analysis

Formerly, two beach zones existed in the area described above. One extended from the Glen River to the Shimna River and the second extended from North of the Shimna Rover all the way to the mouth of Dundrum Inner Bay. Comparison of historical maps of the Newcastle area reveals that major artificial alterations of the shoreline have been undertaken in the vicinity of Newcastle. The first of these involved the stabilisation of the dunes and part of the beach in front of Central Promenade between 1901 and 1919 and the landscaping of the area around the present bandstand. This reclaimed land was fronted by a revetment and promenade. This development occupied a substantial part of the former beach and meant that the area of beach was reduced almost to zero in

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the southern section of this area (waves presently break against the new promenade revetment). The seaward margin of the remaining beach is in the same position as before construction of the Newcastle Centre. The Newcastle Centre was constructed on the central part of the remaining southern beach and occupies part of the former high tide beach and part of the intertidal beach. This effectively bisected the former beach leaving a remnant south of the Newcastle Centre. To the north, sand accumulation has occurred, building a sandy high tide beach between the Newcastle Centre and the Shimna River through accretion of fresh sand, probably aided in part by reinforced concrete groynes.

North of the Shimna River, a 30m-wide high tide beach is evident on aerial photographs of the 1960s and 1970s, although the intertidal area in front of it varies between gravel basement and a thin sand veneer. The intertidal beach is recorded as gravely on every Ordnance Survey map since 1834. A greater sand cover does appear to be recorded by air photographs in the 1970s although the amount of cover is variable in all aerial photographs assessed. Wave analysis (Navas, 1999) shows that this is a persistently low area of wave energy dissipation which suggests that sand accumulation takes place slowly and is probably removed by the shifting channel of the Shimna River. Sand appears to move onshore across this gravel basement as a thin sheet. The amount of sand cover at any given time reflects the balance between onshore sediment transport and sediment dispersal by longshore drift and by river currents.

The high tide beach also varies in width as a result of variable sand availability and is probably affected by the outflow of the Shimna River which modifies incoming waves. Thus a relatively wide beach has periodically occurred adjacent to the Shimna River. Construction of a promenade (Downs Park) during the 1980s at the rear of and partly on top of this beach has reduced its area since then.

Northward, a sea wall has been constructed in front of the Slieve Donard Hotel Grounds and a succession of rock-armour revetments have been constructed in front of the Royal County Down Golf club to stabilise the dune toe. The latter, however, do not extend onto the high tide beach.

Thus, south of the Shimna River, high tide beach area has been lost in the south by land claim (the recreation grounds) and the beach has been bisected by the Newcastle Centre which itself occupies former beach area. North of the Shimna River the high tide beach area has similarly been reduced through promenade construction. Between the Newcastle Centre and the Shimna River, however, the beach has undergone some accretion (i.e. has grown seaward) as the shoreline has adjusted to the new structures.

This narrowing of the high tide beach by stabilization of the landward margin reduces the beaches ability to withstand storm wave attack and could lead to periodic erosion of the entire high tide beach by wave reflection during such intervals.

Since 1861 a considerable volume of sand has accumulated in the nearshore area of Dundrum Bay (Navas 1999). This has had the effect of enhancing northward littoral drift of sand within Dundrum Outer Bay. Wave simulations (Navas, 1999) show that the drift is northeastward in all sections of the high tide beach but that a small drift reversal occurs in the vicinity of the Shimna River outlet. In this drift reversal area sand is transported to the southwest. Simulations indicate that potential cross-shore sand transport is directed onshore at high tide but that it is an order of magnitude lower than the potential longshore transport volume. Given this situation, a retardation of the longshore transport by the construction of groynes may cause retention of the cross-shore transported sand and thus promote accretion of the high tide beach. Since this would involve an artificial advancement of the high tide beach that is presently capable of withstanding wave attack, it cannot be said with certainty that any accreted beach would remain in place after a storm coincident with high tide. Further, the nature and availability of sediment for transport in the nearshore is largely unknown. The accretion of the beach north of the Newcastle Centre does, however, suggest an available natural sand supply, as does the substantial accretion that is recorded in the nearshore through comparison of historical bathymetric charts. That this will provide sufficient sand to fill the increased volume required by Groyne construction cannot, however, be proven. Further, it is possible that pebbles and gravel as well as sand will be trapped by groynes and that any new beach will be composed of whatever sediment is available for transport during sediment transport phases.

It is important to note that the reduction of beach amenity at Newcastle is due largely to building and stabilising works on top of the beach and former dune. The long term behaviour of the seaward margin of the high tide beach does not indicate that there is an erosion problem. Indeed the impression gained of Dundrum Bay is that there is an abundance of sediment.

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Thus any increase in high tide beach area will require an artificial advancement of the existing high tide beach.

4. Proposed measures

a. Groyne positioning

A natural beach attains a shape that accommodates prevailing wind, wave and tidal current conditions and is able to withstand periodic increases in energy level through erosion and recovery. At Newcastle, the low, intertidal section of the beach dissipates much of the incoming wave energy. Energy that remains after traversing the intertidual area is dissipated on or reflected from the high tide beach (sometimes called storm beach). The periodic formation of cusps on the high tide beach results from excess wave energy striking this part of the beach profile. Occasionally, when these energy levels are exceeded, erosion of the dune may occur. It should be recognised that to enhance the size of the beaches at Newcastle (whose area has been diminished by losses on their landward side – not by marine erosion) will require an artificial advancement of the high tide beach section of the profile in a seaward direction. The seaward margin of this beach will thus be subject to higher wave energy than the natural high tide beach and it is to be expected that it will respond by periodic erosion.

Based on the situation outlined above, it is suggested that a series of groynes emplaced on the high tide beach may trap and retain sediment transported onshore by temporarily retarding the longshore transport of such sediment and building a wider high tide beach. When the high tide beach fills the additional space provided by the groynes, sediment bypassing would then occur.

Groynes are frequently used as a means of shoreline protection but it has been claimed that no more than 50% of such emplacements are successful. Indeed, Silvester & Hsu, (1993) indicate that groynes frequently enhance longshore and offshore losses of sediment in coastlines that are undergoing long-term erosion. Conditions for successful groynes emplacement appear to be contrary to those conducive to beach erosion i.e. an abundant supply of sediment should be available. There does appear to be an abundance of sediment within Dundrum Outer Bay and it is on this basis that groynes may be capable of producing the accretion required to enhance amenity beaches at high tide. Flemming (1990) notes that while they are mainly used for coastal protection, groynes can be effective in improving the extent and quality of a recreational beach.

A reasonable recreational beach area exists south of Newcastle Centre although it is poorly maintained. Since this beach appears to have attained stability with the extant wave field and sediment supply, further modification of this area is not recommended. Routine cleaning and possibly mechanical raking of the beach surface, however, would improve its amenity value considerably.

The area between Newcastle Centre and the Shimna River probably represents the best potential recreational beach in the area. It has recently accreted sediment and the loose unconsolidated sand that comprises the beach suggests there is potential for further accretion. The reinforced concrete groynes on this beach are in a poor state of repair and do not extend to the seaward margin of the high tide beach. It is suggested that they be left in place. They should, however, be augmented by a 30m long wooden groyne of a type that, to the north, have evidently withstood exposure to the marine environment more effectively than the reinforced concrete ones. Although there is some debate on the issue (Brampton & Motyka, 1983; US. Army Crops of Engineers, 1992), groyne spacing to length ratios should be determined by reference to incident wave angle. Since most wave crests are close to shore-parallel in Dundrum Bay, this ratio should be in the region of 7 or above according to graphs published by Silvester & Hsu (19977 p288). If the groyne length (and desired high tide beach width) is about 30, the spacing thus indicated is over 200m and thus only one groyne should be required on this stretch of beach.

North of the Shimna River, the present high tide beach offers little recreational potential as it is narrow, pebbly and poorly maintained. (Note that the loss of beach area is due to construction of the promenade on top of the beach). The beach here is, however, easily accessible from the promenade and car park. Here, an attempt to increase the high tide beach width could also be made employing a series of wooden groynes. These should be emplaced in an effort to trap sediment and increase the volume of the high tide beach. These groynes should be 30m long and be spaced at a intervals of

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200m (length-spacing ratio c.7) between the Slieve Donard Hotel and the remnant gabions at the Shimna River mouth. (Three groynes should be installed in the first instance as shown in Appendix 3).

b. Groyne design and emplacement

The groyne should be constructed as follows. Each should be 30m long and be orientated perpendicular to the shoreline. Vertical members should extend to 1m above the beach level and be driven over 1.5m into the ground. The precise design of the wooden groyne is relatively unimportant as long as the timbers are robust and capable of whithstanding marine conditions. The capacity to add and remove horizontal boards readily is, however, a requirement of the design. Existing groyne remnants north of the Slieve Donard Hotel indicate that timber groynes are capable of withstanding conditions in the Newcastle area. Examples of suitable construction design are of recently emplaced wooden groynes at Portballintrae County Antrim.

Experience has shown that groynes are most effective at trapping sand when they are raised gradually (Brampton & Motyka, 1983). Thus it is suggested that the initial horizontal members be exposed only c.0.2m above the contemporary sand surface until they are nearly covered. Then additional planking should be added in phases as sediment accumulates. This should occur from south or north. Ultimately, when a wide high tide beach is achieved, the uppermost groyne board should be at beach level to permit sand bypassing to occur. From a maintenance perspective, buried sections of groynes last longer than those exposed to the air and water and this mode of emplacement will enhance the longevity of the structures.

Initially the horizontal members should be raised to only c.0.2m above the existing sediment level until sediment accumulation occurs. They should be raised progressively as sediment accumulates. To be exposed supratidally the beach surface will need to attain a final elevation of c. 1.0m O.D. Ultimately, if a wide high tide beach is achieved, the uppermost groyne board should be at beach level to permit sand bypassing to occur.

If insufficient sand is available from natural rates of supply, to promote an increase in beach width, consideration may have to be given to artificial nourishment at a future date.

5. Monitoring requirements

The emplacement of the groynes should be accompanied by a monitoring programme to (i) assess their effectiveness, (ii) to prompt the addition or removal of horizontal boards, (iii) to assess the availability of sediment, (iv) to calculate sediment transport rates (v) to monitor scour, (v) to assess alongshore impacts of the groynes and (vi) to advise on the need for additional groynes. Monitoring of the groynes should be undertaken on a monthly basis with an initial survey before construction begins. This should involve a series of cross-shore topographic profiles at 25m intervals with associated sediment sampling and textural analysis for a minimum period of twelve months. Volumes of actual cross-shore and longshore sediment transport should be determined and the fill period for the groynes should be predicted. The survey should extend at least 200m beyond (northward of) the groyne area to determine whether any secondary effects are evident beyond the limits of the groyned area.

The occurrence of scouring adjacent to the groynes should be monitored as enhanced souring could produce losses of sediment offshore. The beach surface adjacent to existing groynes does not show evidence of scouring. Experience

elsewhere suggests that the spacing of the groynes may need to modified by emplacement of subsequent groynes. The need for additional groynes may be advised by the monitoring programme.

If, after twelve months, no sediment accumulation has taken place adjacent to the groynes, a decision should be made as to whether to emplace additional sand from external sources (beach nourishment) or to permit natural build-up to proceed. If nourishment is necessary, it is likely to be a recurrent activity and may need to be replaced periodically. A first order predication of the period between nourishment episodes can be made on the basis of the monitoring programme.

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6. Costs

The experimental scheme described above requires the installation of c. 120m length of wooden groynes in a phased programme comprising initial emplacement of vertical elements and lowermost horizontal elements. This would be followed by irregularly spaced periods during which additional horizontal members would be emplaced.
Costs of groyne construction are currently estimated by the UK Environment Agency in the region of £1000-£1500 per metre length. Local estimates suggest a cost of £900 per metre. This yields a construction price of c.£108.000 to £180.000. The work is to be undertaken at the high intertidal zone and thus the difficulties of working in the intertidal zone are reduced. Adequate storage space exists in the car park to enable construction to proceed from a local base. Since the installation would be phased, however, it could increase the cost by 10-20%.
Monitoring of the beach changes is an integral part of the phased emplacement of these groynes. Monitoring and interpretation at monthly intervals should be done in conjunction with the implementing body (Down District Council) and the construction contractor. Monthly monitoring, calculation of trends and advice on groyne installation is likely to cost in the region of £40.000.
The need for additional material to fill the groynes if natural sand supply is insufficient should be appraised at the end of a 12 month monitoring period and future options should be reviewed.

7. Groyne Design

A number of different types of wooden groyne are available. Ease of removal and addition of planking is required and thus a construction such as that shown below (from Thorn & Simmons, 1971) is likely to be suitable.
Half round piles (300mm diameter) 2.5-3.0 m long at 1.75m centres. Penetration 1.5 m supporting 225 x 75mm planks fixed to the piles with 10mm galvanised spikes 150 mm long or 20mm bolts. Piles should be of a resistant wood such as Oak, Jarrah or Greenhart. Pine should be avoided due to the presence of gravel which will cause rapid abrasion.

References

Brampton, A.H. & Motyka, J.M. 1983. The effectiveness of groynes. In: Shoreline Protection. Thos. Telford, London: 151-156.

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