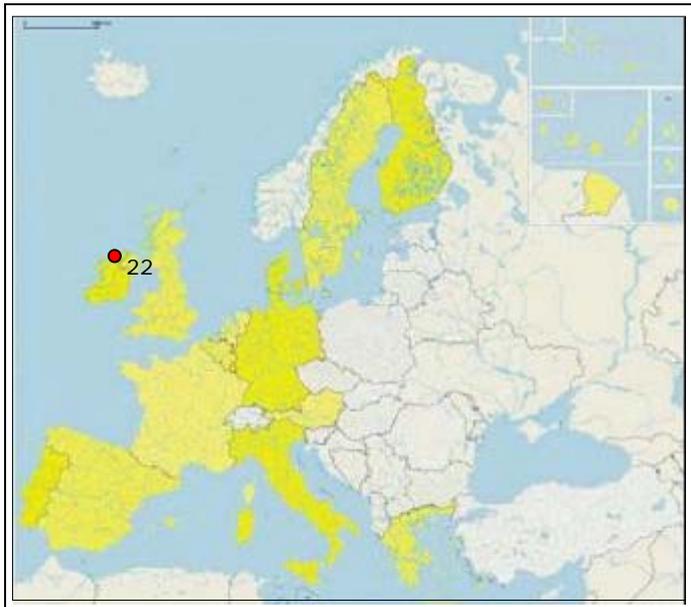

ROSSNOWLAGH DONEGAL COUNTY (IRELAND)



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1.1.2 Geology

➤ Coast of Ireland

Topography, together with linked geological controls, result in extensive rock dominated and cliffed coastlines for the southwest, west and north of Ireland. In contrast, the east and southeastern coasts are comprised of unconsolidated Quaternary aged sediments and less rock exposures. Glacial and fluvial action however, has also created major sedimentary areas on western coasts. The resulting coastline of Ireland is highly irregular and crenellate in form (as can be seen in Figure 2), characterized by a bay-headland type configuration. Coastal settings include rocky open coast, bays and estuaries, raised shorelines and drowned valleys. Significant coastal systems within these include those of cliffs, beaches and barriers (sand and gravel types), lagoons, dunes, machair (sand 'plains'), salt marshes, wetlands and mudflats.

➤ County Donegal

The Rosstown area is located in the County Donegal. The area consists of sandy beach, rocky shore platform, sand dunes, grassland, boulder clay cliffs and rock cliffs. The beach sediments consist predominantly of well-sorted fine sand. Landwards of the sand beach a narrow gravel ridge can be found along most of its length.

➤ Land uplift/ subsidence

In the long-term timescale the Irish Sea region has been repeatedly glaciated, affecting directly the composition of coastal sediments and sediment supply. Some coasts in the northern sector of the region appear still to be glacio-isostatically rising in response to ice unloading (following major ice sheet removal by c.17,000 BP), with relative crustal uplift at rates of less than 0.1 mm up to 0.3 mm/yr. Others argue that these areas are now more or less isostatically stable. Crustal uplift values appear to fall westwards from northern Britain toward Northern Ireland. The current zero uplift isobase runs approximately from Liverpool westwards through to Arklow.

1.1.3 Morphology

As can be seen in Figure 2, the case area Rosstown is located in Donegal Bay. This provides some shelter from the high waves entering from the Atlantic Ocean. However, the beach is still subject to high-energy waves and storm impacts. The beach at Rosstown has the broad low-angle energy dissipative profile typical of beaches that are adjusted to high-energy swell and storm wave impact. Apparently the bay does not provide the case area with a lot of shelter.

The Belalt Strand lies on the eastern coast of Donegal Bay. In the northern end the intertidal rock outcrop of Carrickfad borders the beach (see Figure 3). The beach then extends for over 2 km to the south until it reaches the cliffs at Coolmore in the

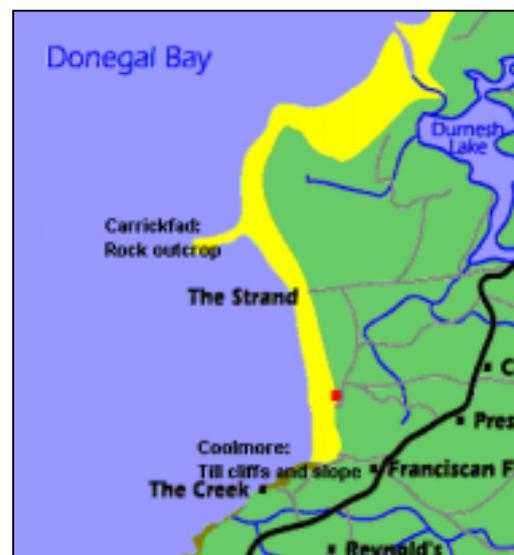


Fig. 3: Overview Rosstown Beach.

south. The beach is backed by till-capped bedrock to the south, sand dunes along the central section and drumlin till to the north.

In Figure 4, the Belalt Strand at Rosstownlough is shown in more detail.



Fig. 4: Detailed view of the case area.

1.1.4 Physical processes

The beach, despite of the location in a bay, is subject to high energy swell and storm wave impact. It has a broad low-angle energy dissipative profile. Major factors in the erosion process in the case area (and virtually all Donegal systems) are:

- Sea level rise;
- Increased storminess in the North Atlantic;
- The surrounding till cliffs are retreating, causing an overall retreat of the coastline;
- More locally sand scarcity.

Tide

The area is subject to high-energy swell. The tidal range in the Donegal bay varies from 1.5 m during neap tide to 4.5 m during spring tide.



Waves

The western coast of Ireland is exposed to the full impacts of Atlantic swell wave and storm activity. Significant deep-water wave heights (H_{sig}) here reach values of 15 - 20 m.

Relative sea level rise (RSL)

Relative sea level rise is determined by the combination of land subsidence or uplift with sea level rise. After the last glaciation period sea level rise has been accomplished at differing rates. The natural pattern of relative sea level change is one of falling levels against coasts in the north of Ireland as the land there continues to lift in response to earlier ice melt and unloading. Relative crustal uplift rates are thought to be 0,1-0,3 mm/year maximal in the north of Ireland.

Storm events

It is predicted that, due to global warming, Ireland will experience fewer but more powerful storms, with especially the northwest and southeast regions becoming more stormy.

1.1.5 Erosion

Erosion rates

The beach of Belalt Strand was originally backed by sand dunes for most of its length. Accretion and dune advance took place between 1836 and 1907. This was followed by a period of stability. Since then, the dominant feature has been progressive erosion. Field evidence suggests that a balanced system alternating between erosion and accretion has been replaced by a solely erosive system.

The central section of the dune front has been progressively eroding at rates up to 0.6 m per year for the last sixty years. The southern and northern ends are retreating at lower rates. No evidence can be found of contemporary dune building processes. From 1972 on several parts of the dune front have been armoured. These armoured locations have not retreated since their construction, leading to a very irregular dune front. The northern part of the beach, with till shores (Carrickfad outcrop and the beach just south) showed little change between 1951 and 1977, but considerable retreat thereafter.

Natural erosion

Several reasons are thought to be responsible for the retreat of the coastline. The majority of Irish dune systems and virtually all Donegal systems are retreating (due to sea level rise, increased Atlantic storminess and more locally sand scarcity). In summary, natural processes are trying to move the Rosstown beach and dunes to a position further east.

Erosion due to human interference

Another possible factor in the acceleration of dune erosion may be the progressive reduction of the substantial cobble storm beach that lies between the dunes and the beach. This storm ridge varies considerably, but it is believed to have virtually disappeared over the years due to human interference. Some storms reveal the masses of gravel, by lowering of the beach

and trimming of the dune front. In one occasion (Jan 4 1999) some 20 m of gravel was revealed near the public car park where previously only 5 m was visible. It is thought that large quantities of gravel were removed for building purposes and (especially the attractive flattened cobbles) by tourists. At present the reduced storm ridge is less capable of dissipating the wave energy, causing an increase in erosion.

Furthermore, due to pressure from recreation (trampling by tourists and vehicles on the beach and in the dunes, tourist accommodations in the dunes) the variation in species is reduced and thus the natural resilience of the dune and beach system is threatened. This can also cause an increase in erosion.

1.2 Socio-economic aspects

1.2.1 Population rate

During the summer up to 2000 people can be found in holiday homes and caravans. On fine summer Sundays the number of visitors at Belalt Strand can be as high as 8000. During winter the number of residents falls to some 200. The case area is not densely populated, less than 250 persons/km² reside in the area.

1.2.2 Major functions of the coastal zone

- **Tourism and recreation:** The major function of Belalt Strand is tourism and recreation. The area is renowned for its surfing waves. Most people visit the beach for physical activities like surfing, swimming, walking and beach games. From a survey, which was carried out in 1998 the following activities were offered by the respondents (it must be noted, that the results may have been slightly biased by the relatively poor summer, with less than normal visitors at the beach):

Table 1: Activities carried out on Belalt Strand in 1998.

1. Walking (86%)	6. Picknicking (49%)
2. Swimming (72%)	7. Sightseeing (42%)
3. Relaxing (70%)	8. Sandcastles (40%)
4. Sunbathing (67%)	9. Surfing (35%)
5. Beach games (51%)	10. Reading (33%)

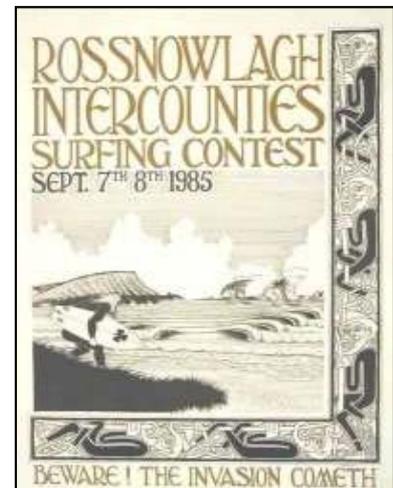


Fig. 5: Surfing at Rosstownlagh.

- **Nature conservation:** Currently none of the dune area is protected by nature conservation designations. The area was excluded from the Durnesh Natural Heritage Area, due to the fragmentation and damage caused by tourist and infrastructure development and recreational pressure.

No sand hoppers have been observed on the beach. Unarmoured sections of the beach lack fore dunes or marram-dominated semi-fixed dunes, which would indicate dune development or recovery.



The rocky shore platforms consist of two main sections: a zone of green seaweed (*Chaetomorpha linum*) and the second one of bladder wrack (*Fucus vesiculosus*) with more abundant fauna, such as limpets, barnacles and mussels. The southern shore platform is backed by boulder clay-clapped rock cliff composed of interbedded Carboniferous limestone and shale. On this rock cliff willow/gorse scrub and fen meadow grassland have developed. Species like devil's bit scabious and Grass-of Parnassus can be found here.

The Rabbit Warren (north of the public car park) forms the largest area of intact sand dunes. It is occupied by fixed dune vegetation of European Union Habitats Directive Annex 1 type. Different plant communities can be found on drier ridges, damper hollows and disturbed areas. Per standard 4 m² area on average about 15 species can be found. This is less than the 18-20 species in the dunes north of Rosstown beach. The dominant species are the same however, like red fescue, marram, orchids, violets and harebells. In the Belalt Strand dunes also species can be found that indicate trampling, disturbance and enrichment, like reseete plants, nettles, mayweed creeping bent and cough grass.

1.2.3 Land use

Rosstown is a major holiday resort. Land use consists mainly of caravan sites, holiday homes, a hotel, and a public car park near the beach. By 1999 up to 25% of the area between the Sand House Hotel and the New Line Road was developed in this manner. A small area of degraded dunes has been used to over-winter cattle. Stock densities have been very high with around 20 cattle in an area of approximately 2.5 ha.

Overall, it is assumed that natural dune development is unlikely, even with restoration schemes like marram planting, control of trampling pressure and littering. Surrounding areas have higher biodiversity and are better candidates for nature conservation purposes.

1.2.4 Assessment of capital at risk

According to Bryant et al (1995) at Rosstown the capital at risk is very low. However, the recreational value of Belalt Strand is considered to be high and therefore measures were taken.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

The last sixty years the central section of the dune front at Rosstownlough has been eroding at rates up to 0.6 m per year. Further in the past evidence has been found (from Ordnance Surveys, back to 1836) that accretion periods have existed. From around 1951 (objective information) however, the beach has progressively been eroding. The northern and southern extremities (Carrickfad rock outcrop and Coolmore till cliffs) are eroding at a lower rate of about 0.1 m per year.

A dramatic piece of evidence for erosion in the past lies in the present location of two military blockhouses, built in the dune line in 1940. The southern blockhouse now lies on the beach surface. It is said to have collapsed on the beach after a few years. Aerial photographs, taken in 1951, show the blockhouse some 13 m out from the dune scarp. By 1990 it lay some 26 m from the eroding dune scarp and currently it lies 33.5 m from the base of the eroding dunes. The northern blockhouse now lies on storm beach gravels at some 5.5 m out from the backshore scarp. Here the till substrate gives the coast more resilience to erosion.

Erosion in the central area was highest between 1951 and 1977. Construction of rock armour, which started with armament of the dune front in front of the Sand House Hotel, has stopped erosion at these locations. The rock armour was not placed in one long protection, but in an ad hoc manner over short lengths. Between these armoured sections erosion has continued, giving the dune front a ragged appearance. Between the Sand House Hotel armouring and the Swan Lake caravan park armouring an indentation of 35 m has eroded.



Fig. 6: Armoured section at Sand House Hotel.

2.2 Impacts

The Rosstownlough beach is a major recreational area. When, due to ongoing erosion, recreational facilities are lost, the area will become less attractive for tourists. This will severely hamper the local economy. Due to 'end-effects' already parts of the armour are being degraded and the unprotected parts of the dune front continue to cut deep gaps into the dunes.

The armour protects the dune front, but wave reflection and subsequent scouring seriously damages the recreational beach by removing sand. This is a serious threat at Belalt Strand where the flat to concave beach profile and the absence of sand accumulation structures suggest that sand supply is limited.

3. SOLUTIONS/MEASURES

3.1 Policy options

Two strategic policy options have been devised for the future, a short term (five year) and a long term (twenty year) objective:

1. The short-term objective is to improve beach safety and access for pedestrians. Water-based recreation conflicts have to be resolved and environmental considerations and resident opinion should be incorporated in development planning.
2. In the long term, the environmental quality of the site must be enhanced, a current or even increased number of visitors should be accommodated and the Belalt Strand and dunes should be developed in a sustainable manner.

Up until now no overall policy option has been adopted at the case area, locally hold the line has been adopted. The future policy option is yet to be determined (see Section 3.2: Strategy).

3.2 Strategy

3.2.1 Approach related to the problem

The proposed strategy towards the stated objectives is as follows:

- A detailed technical report should establish the likely risk of scouring and lowering of the beach, when additional armouring is adopted;
- Depending on the outcome of above mentioned report the un-armoured sections of the dune front should be armoured;
- If the outcome of the above mentioned report indicate serious risk of beach lowering, it is suggested to accept a status quo, where no further armouring is accepted and no further facility development should be allowed seaward of the Golf Links Road.

In more detail, five measures have been proposed as future options for shoreline management with their (dis-) advantages:

- a) *Maintain the current pattern of armoured and un-armoured sections ('Do nothing')*
 Advantages: protects existing development, no further expenditure
 Disadvantages: un-armoured sections will continue to retreat, unsightly
- b) *Maintain the current pattern of armoured and un-armoured sections and use soft engineering methods to accumulate sand on the remaining natural shoreline, e.g. brushwood fences ('Limited intervention')*
 Advantages: halt or slow down retreat, low expense, environmentally benign
 Disadvantages: may be ineffective as sand supply is limited, high maintenance
- c) *Upgrade currently ineffective sections of the rock armour ('Hold the line' and 'Do nothing')*
 Advantages: moderate expense, more effective defence of property
 Disadvantages: un-armoured sections will continue to retreat



d) *Fully armour the shoreline ('Hold the line')*

Advantages: avoids fragmentation of the shoreline, links isolated armoured sections, provides opportunities for development

Disadvantages: formalises shoreline, expensive, accelerated beach lowering possible

e) *Remove all current rock armour ('Do nothing')*

Advantages: reinstates natural shoreline and coastline processes, supports 1996 Draft Development Plan strategy of accommodating shoreline change

Disadvantages: retreat inevitable, threat to infrastructure, compensation expensive

For dune management the following measures are proposed:

a) *No management (the current situation)*

Advantages: none

Disadvantages: further degradation of the dune system

b) *Environmental reserve (ecological restoration, fenced perimeter and paths)*

Advantages: enhances wildlife habitats

Disadvantages: reductions in numbers able to use the dunes, requires considerable effort in relation to its size and value for conservation

c) *Informal park and playground (fenced perimeter)*

Advantages: retains full public access

Disadvantages: does not provide new recreational facilities

d) *Formal recreation and development of facilities (options include picnic tables, golf course, playground, car park, camp sites, sports pitches etc.)*

Advantages: increases number of recreational facilities

Disadvantages: loss of dune habitat

It is further suggested that fencing and sleeper (boardwalk) paths should be constructed to encourage the visitors to use way-marked paths and to protect the dunes from heavy use degradation. Rosstown has become an amenity area that has lost much of its conservation value. As such it is suggested that management strategies are compatible with its status.

3.2.2 Issues concerning threat to life and property

Information is unavailable.

3.3 Technical measures

3.3.1 Historic Measures

Up until now, armoring has been applied to protect specific locations of the dunes. In 1972 the first stretch of armoring was designed and constructed in front of the Sand House Hotel. Later, private landowners have protected their property by constructing (short) stretches of rock armour on an ad hoc basis. These armour sections are badly designed and constructed. At present, seven sections of rock armour cover a total distance of circa 750 m,

this is about half the sandy shoreline. The rock armour has been effective in stopping the erosion at these locations. The unprotected locations however keep retreating. The armouring has also led to increased erosion of the unprotected areas, due to 'end-effects'. As a result the dune front is currently very fragmented, the coastline is composed of linear armour sections alternating with further retreated eroding natural dune sections. These cut deep gaps and hollows in the dune front.

Even with armour in place large storms can still do damage. The large, but not exceptional, storm of January 4 1999 threw large quantities of debris up onto the car park landward of the Sand House Hotel's substantial revetment. Furthermore, armour sections to the north show clear signs of storm damage.

3.3.2 Type

Aside from the currently applied rock revetments, two possible types of protection have been proposed for the future:

1. Armoured revetments;
2. Re-nourishment of the dunes in combination with soft engineering techniques, like revegetation of the dunes or brushwood fences.

These types of protection have been proposed singly (one type for the whole dune front) or in a combination where some stretches of the dunes are protected using armoured revetments and in other stretches the dunes are renourished and revegetated.



Fig. 7: Present rock revetments at Belalt Strand.

3.3.3 Technical details

The dune front has been armoured on an ad hoc basis since 1972. At present (that is: by 1999) there are 7 sections of rock armour covering a total distance of 755 m. This means half the sandy shoreline and about 33% of the total coastline of Belalt Strand is protected by rock armour. The longest stretch (225 m) can be found in front of the Sand House Hotel and in general the length of the stretches vary in length between 20 m and 225 m.



3.3.4 Costs

Information is unavailable

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

At the locations where rock armour was constructed to protect the facilities behind it, erosion of the dune front has stopped. Due to the reflection of the incoming waves lowering of the beach in front of the armouring is thought to have continued or even worsened. The apparent lack of sand in the area and the absence of a berm (a convex mound of sand above high tide level) with dry sand, causes a lack in sand accumulation, and thus no dune advance. Furthermore, the armoured sections have been damaged during severe storms.

Between the armoured sections retreat of the dune front has continued at previous rates. Near the end of the armoured sections 'end-effects' have been spotted, leading to the assumption that locally, erosion may even have been increased by the construction of the rock revetments.

4.2 Effects related to socio-economic aspects

As none of the recreational facilities has been abandoned/lost to the erosion, no effects on user functions have been noted. However, due to the erosion of the beach and the 'unsightliness' of the beach (as a result of the scattered armouring and erosion gaps in the un-armoured dune front) the Belalt Strand is becoming less and less attractive for tourists.

4.3 Effects in neighbouring regions

Even if locally erosion can be stopped at the sandy beaches by taking measures (nourishment or further armouring), the nearby till cliffs will keep eroding at a slow pace. It is thought unrealistic and not favourable to armour these sections of the area. Thus in the future, due to the slow, but progressive erosion, further measures may be necessary.



Fig. 8: Large armoured section at Sand House Hotel.



4.4 Relation with ICZM

Donegal County Council and the University of Ulster (Coleraine) are currently developing management plans for beaches and dunes in the north of Ireland. This three-year project, launched in 1997, is co-funded by the European Community under the LIFE Programme. Forming part of the European network, it is designed to demonstrate the practice of Integrated Coastal Zone Management by developing and implementing sustainable uses of dune systems.

Implementation began with awareness raising at a number of levels (e.g. interpretation boards, articles in the news media, scientific presentations, inter-governmental meetings). It continues with the production of a brochure, newsletters, regular web-site updates and public meetings. The project has also contributed to the recently launched draft Coastal Zone Management Policy for Ireland, and participates fully in meetings of the European ICZM demonstration programme. The management plans will be implemented in 1999 and 2000 using LIFE project resources, and by seeking additional funds at regional, national and international levels. It is envisaged that beach/dune plans will be reviewed within the framework and time-scale of the Donegal Development Plan. The project also plans to produce a good practice guide for community-based sustainable coastal management.

In conjunction with the LIFE project in the area two major reports were written:

- In 1996 the Rosstown Draft Development Plan was written. This Development Plan envisages further development within the site boundary in the central section of Belalt Strand. The dune and till grassland north of the New Line Road is also zoned for development, including a car park. In the southern and central sections immediately landwards of area covered by this management plan, and interfacing with it, there are proposals for extensive residential and commercial development. These include several housing clusters, constituting in effect two new villages, a golf course and amenity areas. The first phase of this housing development has already been completed.
- In 1997 a Coastal Zone Management plan was drafted for the whole of Ireland. However, due to lack of funding, gaps in legislation and lack of knowledge of the exact state of the erosion in the area, no ICZM has been implemented yet. In all propositions for the future protection however, a sustainable development of the beach and surrounding area is envisaged.

4.5 Conclusions

Effectiveness

Current measures for protecting the dune front of Belalt Strand have been effective locally, but due to the ad hoc basis on which they were implemented they are not really effective for the overall beach development. An irregular and manmade coastline has come about, with rock armour sections alternating with the remaining natural stretches of dune.

Currently future sustainable development and protection of the area is being studied more integrally. Several options for future development have been proposed and analysed, but no detailed actions have been implemented yet.



Possible undesirable effects

At present, parts of the beach are protected by rock armour. Armour prevents the beach and dune to function as a dynamic system by presenting a barrier. Thus the beach can no longer adjust to storm waves by eroding dune sand. Incoming wave energy is now reflected rather than being harmlessly dissipated. Wave reflection from the armour often causes scour, leading to beach narrowing, steepening and lowering. In summary, armour may 'save' the dunes at the expense of the beach. Furthermore, the rock revetments have been damaged in the past after severe storms.

Gaps in information

No information could be found on costs of taken measures and estimated costs of different proposed measures for future development. Different options have been weighed using general remarks as 'cost effective', 'expensive' and 'high maintenance'.



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