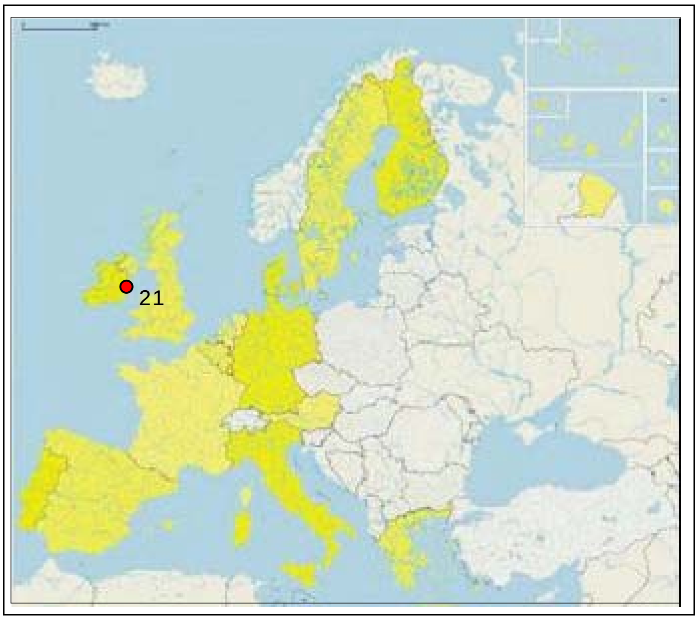
ROSSLARE
WEXFORD COUNTY
(IRELAND)



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1. GENERAL DESCRIPTION OF THE AREA

1.1 Physical process level

1.1.1 Classification

Unlike the UK, Ireland has been rising out of the sea since the last ice age. Scientists think that the island has stopped rising and the sea level rise will become a bigger threat in the future. The biggest threat is climate change. The increase in sea level and high tides will produce a new threat to the coastline and with it fears for buildings and infrastructure along the shore. The case area is located at St. Georges Channel.

Fig. 1: Location of case area.

The case area consists of soft glacial cliffs at the southern end and sandy beaches at the northern end. According to the typology in the scoping study the case area consists of:

1b. Tide-dominated sediment. Plains.
Barrier dune coasts

2a. Soft cliffs
High and low glacial sea cliffs.

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 1) characterized by a bay-headland type configuration. Coastal settings include rocky open coast, bays, 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.

Fig. 2: Map of Rosslare area.

- **County Wexford**

The Rosslare area is located in the County Wexford. The Leinster Chain, with its granite core and margin of mica-schist, bounds this county on the west. From this, Silurian ground stretches to the sea, like a platform with a hummocky surface, numerous intrusive and contemporaneous felsitic lavas, and some diorites occurring along the strike in continuation of the Waterford series. Along the Wexford coast, greenish slates like the Oldhamian series of Wicklow form a broad band, with Old Red Sandstone and Carboniferous Limestone above them near Wexford. Silurian beds appear again towards the south coast of Wexford. The surface of the county is much modified by glacial drift, and by the presence of sands and gravels of pre-glacial and possibly late Pliocene age.

- **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 crustal uplift at rates of <0.1mm - *c.*0.3mm/yr. Others argue that these areas are now more or less isostatically stable. The current zero uplift isobase runs approximately from Liverpool westwards through to Arklow. South of this line coasts lie with isostatic crustal stability to marginal subsidence, with values of <0.1mm/yr.subsidence, though anomalies to this pattern may occur.

1.1.3 Morphology

Ireland's east coast is less indented than other Irish coasts and is approximately 480 km in length. The hinterlands are among the drier parts of the country, having on average less than 150 days per year with more than 1 mm rainfall. The shoreline is characterized by softer forms of intertidal substrate and includes extensive linear sandy beaches. With the notable exceptions of Dublin Bay and Wexford Harbour, the coast is distinguished by an absence of bays and inlets and a transition from mainly harder intertidal substrates in the north to extensive sandy beaches in the south.

Rosslare Strand is situated within a bay bounded by the headland of Greenore Point to the south (glacial cliffs) and on the north by Raven Point to the north of the entrance to Wexford Harbour (see Figure 3). The bay at Wexford consists of sand banks and mud flats. The marl cliffs at the southern part of the bay fall in height and merge with the sand dunes at Rosslare Strand Village. Sand dunes fronted by a sand beach (called "the Strand") extend northwards for nearly 5km to Rosslare Point. Sand banks are present in front of the coastline, up to 5 km away from the coast.

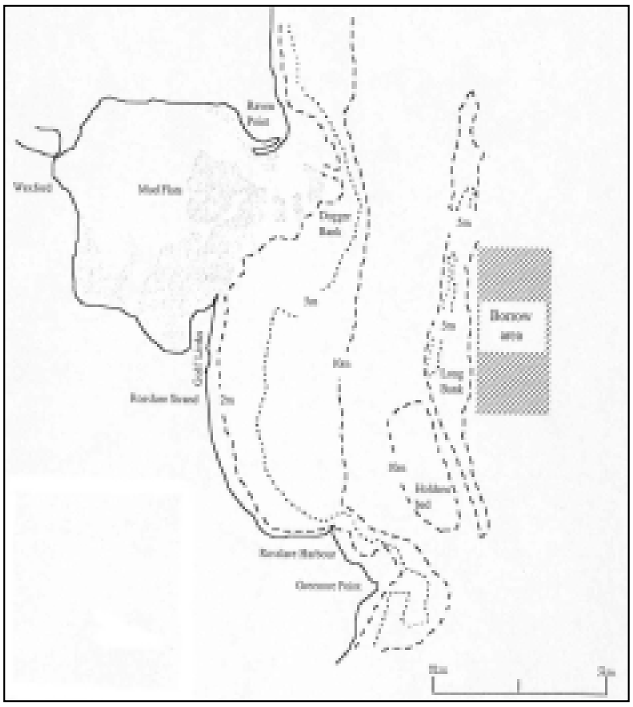

Fig. 3: Bathymetry Rosslare Bay.

Erosion of the marl cliffs at the southern end of Rosslare Bay provide little beach building material as approximately only 16% of the eroded material is capable of residing on the beach. The remaining finer material is carried offshore by wave action.

1.1.4 Physical processes

Tide

The tidal regime is micro tidal at Rosslare (<2m spring tidal range). The tidal range varies from 1,5 - 2 m. Tidal action causes tidal streams, ranging from 1-2 m/s.

Waves

The Strand is open to waves from the north-northeast round to the south-southeast and, with a predominance of wave activity from the southeast resulting from long period swell diffracted into the Irish Sea from the Atlantic, there is a net wave-induced south to north littoral drift along the shore.

Wave heights and the wave energy regime around Ireland reduce eastwards into the Irish Sea region (H_{sig} modal values of *c.*1.6-2m). Though the coasts here remain storm influenced they receive only c. 20% of the wave energy levels occurring on open Atlantic coasts.

Sea level rise and land subsidence (RSL)

Relative sea level rise is determined by the combination of land subsidence or uplift with sea level rise. Postglacial rebound is the main contributor to land subsidence/uplift in Ireland. 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. Southward, where the case study Rosslare is located, land levels appear stable, or sinking only gradually, with RSL rise at rates of at most 0.5mm/year.

Wind

In Figure 4 the wind rose is shown for the period 1966-1994 at Rosslare Harbour. Winds from the corner west to south are most common in this area.

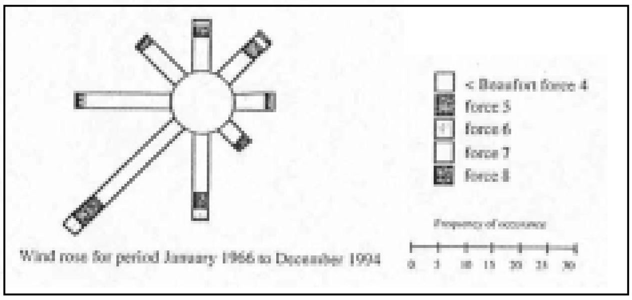

Fig. 4: Wind rose at Rosslare Harbour.

1.1.5 Erosion

The net longshore transport at Rosslare is directed northwards. Coastal erosion has been a problem at Rosslare Strand for many years. At the northern extremity of the Strand, in the past a spit extended much further north of its present position. The previous spit had been the site of a Fort, a village and a life-boat station; it was abandoned in early 1920's, because the spit was severely cut back by erosion. At the southern extremity recession of the glacial cliffs has taken place. In the middle section of the Strand, recession of the dune ridge has occurred.

The erosion at Rosslare Strand is mainly caused by human interference with the natural sediment movement patterns in Rosslare Bay:

1. Land reclamation of slobs between 1845-1855

   Between 1845 and 1855 approximately 2319 acres of the north slobs in Wexford Harbour and 2293 acres of the south slobs were reclaimed, this caused a change a tidal volume and thus a change in flow and sedimentation patterns. This mainly influenced the long spit present at that time, and the northern end of the Strand.

2. Harbour construction

   The construction of the new piers and the works in Rosslare Harbour to accommodate the modern facilities for the ferry companies, and their passengers in the early 1980s, has resulted in the sediment starvation of Rosslare Strand by interfering with the natural tidal flows and sea currents which for centuries replenished the beach on an ongoing basis. The erosion of the beach corresponded with the development of the port.

1.2 Socio-economic aspects

1.2.1 Population rate

Rosslare is not densely populated; the population of Rosslare counts about 1000 people. The population density is less than 250 persons/km^2.

1.2.2 Major functions of the coastal zone

- **Nature reservation:** Bird areas are present at Rosslare Strand.

- **Tourism and recreation:** Stretching along the curve of the bay, Rosslare is Wexford's original holiday resort. Blue flag beach, excellent water sport amenities, and a reputation for hospitality, has always made Rosslare popular with visitors.

Fig. 5: Ferry boat.

- **Industry, transport and energy:** Rosslare Europort is one of the two major ports on the east coast of Ireland. Rosslare caters mostly as a ferry port and a ro/ro terminal while Wexford serves as a fishing port. Rosslare Europort is Irelands second largest passenger port, with sailings to the UK and mainland Britain.

1.2.3 Land use

Most of the coastal area at the case area consists of coastal dunes and recreational facilities. Furthermore, the Rosslare Europort determines a large part of the land use at the case area.

1.2.4 Assessment of capital at risk

Since the area is not densely populated, the capital at risk is low. However, the recreational value of Rosslare Strand is considered to by high and therefore measures were taken.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

A number of Ordnance Survey maps were used to establish early recession rates at Rosslare. Figure 6 shows the coastline extracted from the OS surveys using ACAD along with the latest OS 1:2,500 maps of 1994 recently obtained in draft form from the Ordnance Survey. Results of OPW surveys of the Strand and surveys of the cliffs by CIE and aerial photographs from 1957, 1971 and 1985 were also used to calculate coastal recession. Erosion rates vary from 0,5- 1 m/year and are at present highest in the middle section of the beach.

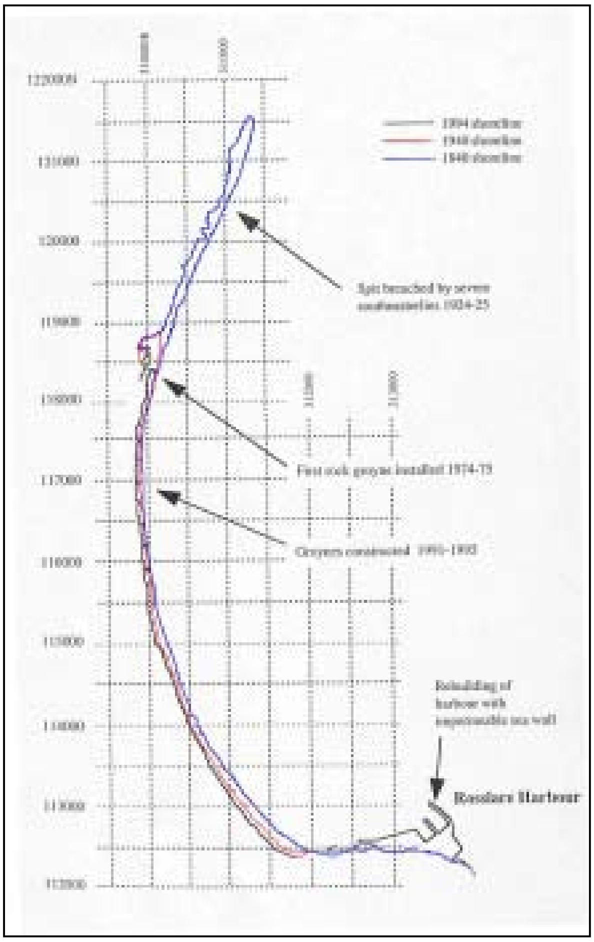

Fig. 6: Shorelines 1994, 1940 & 1840.

Problems of erosion have been attributed to human interference with the natural sediment movement patterns in Rosslare Bay. From various historical documents a detailed account of the influence of these activities on coastal change at Rosslare Strand was established.

- **Land reclamation**

Between 1845 and 1855 approximately 2319 acres of the north slobs in Wexford Harbour and 2293 acres of the south slobs were reclaimed. The reclamation resulted in a 50% decrease in the inter-tidal area in the harbour and a 10% reduction in the tidal volume. This change in tidal volume of the estuary resulted in changes in the flow and hence the pattern of sediment deposition at the entrance to the harbour. This resulted in the failure and recession of 3.5 km of the spit, with accompanying large-scale recession of the shoreline at the northern end of the Strand.

- **Construction Rosslare Harbour**

Construction of Rosslare Harbour in the late 1860's resulted in an interruption of the natural alongshore movement of sediment into Rosslare Bay. At construction, to accommodate this alongshore movement and allow sediment bypassing, a viaduct connecting an offshore pier to the shore was provided. However shelter afforded by the offshore pier resulted in sediment settling in the lee of the pier thus necessitating a programme of maintenance dredging. Between 1913 and 1960 1.2 x 10^6 m^3 of dredge material was dumped offshore and lost to the coastal system. From 1964 to 1978 425,371 m^3 of this dredged material was dumped off Rosslare Strand as beach nourishment. In 1978, CIE closed off the viaduct thus eliminating the maintenance dredging requirements. The new harbour configuration now acted as a large groyne trapping large quantities of sediment on the updrift side and any sand bypassing of the harbour now results in this material being pushed offshore into deeper water to be lost from the active beach system.

2.2 Impacts

The impact of erosion on socio-economic functions mainly consists of the impact on the available beach area and the infrastructure backing the beach. A breach in the coastal dunes can in an extreme event also cause the flooding of Wexford's town and harbour area.

In the past along the Strand, beach erosion has resulted in a reduction in the beach area and damage to properties and infrastructure backing the beach. Furthermore, a Fort, village and life-boat station have been abandoned in the 1920's because the spit at Rosslare was cut back.

3. SOLUTIONS/MEASURES

3.1 Policy options

Because of the land uplift in the last centuries, Ireland is almost unprepared for any serious erosion and has no clear strategy for the future. With increasing sea levels, high tides and more violent weather the coastal erosion will become an important issue in Ireland. Should Ireland try to protect its shores or allow some them to slip back into the sea? At present, these decisions have to be made locally. No general policy option is available. In the case area, the chosen policy is ‘hold the line’.

3.2 Strategy

In 1957 the Office of Public Works began measures to protect the Strand consisting of the construction of timber groynes and breastworks. These works succeeded in slowing down the erosion and holding a fixed position of the shoreline. However the success of the breastworks at reducing coastal recession led to a reduction of sediment quantities available for the natural alongshore drift. This reduction in available sediment along with the vertical nature of the timber groynes and breastworks works, which reflected wave energy, resulted in a lowering of the beach level. Furthermore, the cost of maintenance of the timber groyne system was spiralling in time.

It was evident that a more permanent solution to the problem was required and in 1989 Hydraulics Research Ltd. (HRL) were approached to carry out a detailed study of the strand area. An experiment by OPW (1974) with a rock groyne turned out to be very successful. In 1990, HRL recommended the construction of rock groynes and the provision of additional beach nourishment as the optimum solution to prevent further erosion at Rosslare. With the limited funds available annually a programme of phased development of this scheme was devised which allowed for construction of the groynes over a number of years without the immediate need to nourish the strand. Two 50m-length groynes were constructed in 1990 and in 1991 these were extended to their full length and four other 50m groynes were constructed.

3.3 Technical measures

3.3.1 Historic measures

- Timber groynes, ca. 1957
- Breastworks, ca. 1957
- Rock boulders at toe of glacial cliff over 300 m, successful, 1980s
- Rock armour on dune face, success varying

Fig. 7: Historic timber groynes at Rosslare Strand.

3.3.2 Type

Rock groynes

The groynes are used to slow down the littoral drift of beach sediment due to wave action. Beach sediment is trapped at the updrift side of the groynes (i.e. the south side in Rosslare) resulting in a widening of the beach. At the downdrift side, due to the reduction in sediment passing of the groyne, some local erosion occurs. To limit this downdrift erosion, a groyne length of 100 m and a spacing of 300 m was applied (these dimensions followed from the results of numerical models). The coastal protection plan consists of six groynes.

In the 1980s a rock groyne had been constructed at the north end of the Strand. From analysis of the performance of this groyne designed by the Dept. of the Marine, the proposed cross section of the groynes was adjusted so as to minimise erosion at the downdrift side of the groynes during Northeast storms. The downdrift side of the groyne was reduced to a 1:4 slope so as to minimise wave reflections from the structure and hence beach scour in this area.

Beach nourishment

After the construction of the rock groynes in 1991-1995, the groyne bays were nourished. The median grain size of beach material established from beach surveys carried out in 1987 and 1989 was 0.24 mm. Additional beach samples were obtained in May 1994 and the median grain size of these samples was 0.25 mm. Gravels, which were included in some of the samples, were ignored, as this material is not considered to be part of the active beach system.

Seabed sediment surveys were carried out in 1987 on the offshore sand banks: Long Bank, Holdens Bank and Dogger Bank. Suitable nourishment material was identified on Long Bank. From analysis of this material, the results of a numerical model and the ongoing monitoring of the beach, a requirement of 162,000 m^3 of beach nourishment was established.

3.3.3 Technical details

Rock groynes

- **Rock armour**

The cross section of a typical rock groyne is shown in Figure 6. All groyne construction was by public tender. The rock armour consisted of "irregular individual boulders of good quality sound rock in sizes 1000 – 2000 kgs with the average weight not less than 1700 kgs". The rock was free from cracks, seams and similar defects. Rock armour used in 1991, 1993 and 1995 was a hard volcanic rock called granite diorite, with a specific gravity of 2.66 T/m^3. In 1992, rock was obtained from a quarry, approximately 12 miles from Rosslare. This proximity to site was reflected in rock price. This rock was a quartzite with a density of 2.7 T/m^3. However, due to fracture planes in this rock it proved difficult to obtain suitably sized rock armour to meet the specification and delays were encountered in obtaining rock from the quarry.

Due to the difficulty in obtaining required rock armour in 1994, 50% of the rock was obtained from County Wicklow. This rock was transported by train from the quarry to a disused rail siding near Rosslare and then by road to the site. This rock was dolerite whinstone with a rock density 2.9 T/m^3 and absorption of less than 0.4 %.

- **Filter material**

Underlayer filter material consisted of irregular good quality sound rock, between 10 kgs and 100 kgs in size with the average weight not less than 70kgs. The filter rock used was weathered granite diorite and quartzite.

- **Core material**

The core material consisted of quarry run rock with no material containing mud, top soil or any other organic and was close to Rosslare Strand.

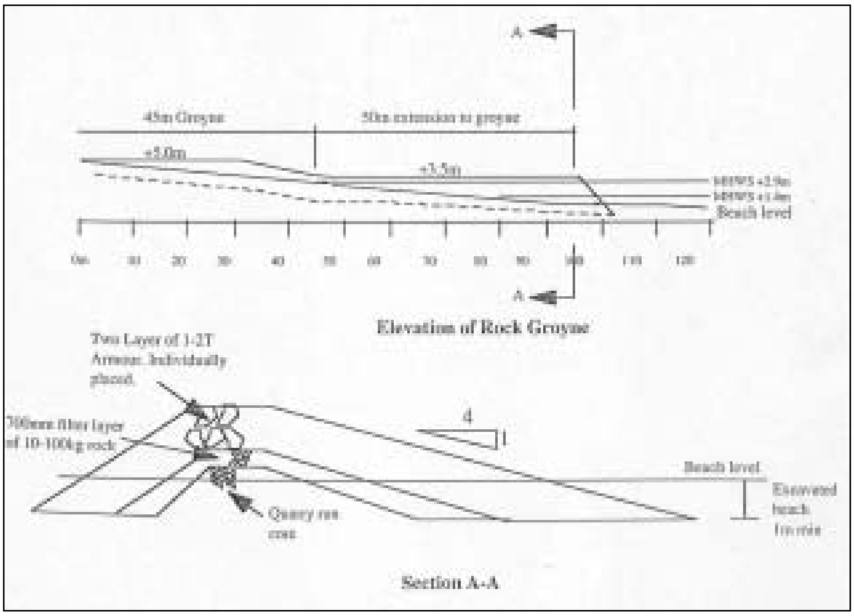

Fig. 8: Typical cross section of a rock groyne at Rosslare Strand.

- **Project execution**

The rock armour was transported to site using six wheeled on-off road dump trucks. The filter rock was transported to site by heavy-duty steel bodied road trucks and stored in a stockpile at the back of the beach. Six wheeled dump trucks were then used to transport it as required to the groyne on the beach. Similar arrangements were used for the quarry run core material. Typically a 33 T Excavator with a 2 m^3 bucket was used to place the rock materials. The rock armour forming the outer layers were placed individually and interlocked tightly with one another to prevent rocking and escape of under layer material.

For the initial 50-metre section, work commenced at both ends and progressed to meet in the middle. This allowed work to proceed at most stages of the tide. The core was placed first and covered with the filter layer and armour units as work proceeded seaward so as to prevent loss of material in adverse weather conditions. For the outer 50-metre extension, an access road on top of the initial section of the groyne was made of beach sand and quarry run material and the groyne extension proceeded seaward. Work on the groyne extension was limited to times of low water with rock being placed underwater. This placement of rock being difficult to inspect and measure resulted in increases in rock quantities over the estimated quantity. Approximately 5,600T of rock armour, 2,000T of filter rock and 800m^3 of quarry run core material was used in the construction of the groynes.

Beach nourishment

- **Project execution**

Nourishment commenced on 1 st October 1994 and was completed on 15th January, 1995. Downtime due to poor weather conditions resulted in 31 days being lost (i.e. approx 34%). Work was carried out on a 24 hours/day, 7 days a week basis.

The sequence of work involved in nourishing a groyne bay was as follows: prior to commencement of nourishment of a bay, a joint pre-survey was carried out by the Contractor and the Department as specified in the tender documents. Land based plant and a small tug boat were used to position the 400 m floating pipeline at the southern end of the groyne bay and a retaining bund, to minimise losses when material was pumped ashore, was constructed by a Caterpillar D6 bulldozer.

The trailing suction dredger "Neptune" was used to dredge material from the offshore borrow site, the seaward side of Long Bank below the 10 m Chart Datum depth contour, and pump it ashore via the floating pipeline. The cycle time for dredging, pumping ashore and return to borrow site was 3.5 - 4 hours approximately, with the typical discharge load being 800 – 825 m^3.

After material was pumped ashore the pipeline was moved progressively along the beach and the material bulldozed to the specified profile. To minimise the requirement to have to come back and place additional material to make up any shortfall or losses due to wave action, the contractor chose to overfill the groyne bays by up to 0.5 m in places. This overfill was not included for payment. On completion of a groyne bay, an out survey was completed and completion of the bay agreed soon thereafter.

To ensure material complied with the specified grading of the nourishment material, following discharge of the dredger the nourishment, material was sampled from the beach and analysis carried out on a representative sample for every 5000 m^3 of material pumped ashore. The median grain size of the material sampled on the beach after the dredger discharged on to the beach was 0.30 mm.

Fig. 9: Rosslare Strand.

- **Nourishment losses**

From the dredger records, a total of 276,788 m^3 of material was pumped on to the beach. The final measured quantity was 162,000 m^3, which suggests total "losses" of 40%. These "losses" consist of:

1. Natural losses in plating the material as fine material is carried off the beach during the pumping ashore;
2. Removal of material placed on the beach by wave action during poor weather conditions prior to measurement. These conditions resulted in 34% downtime during the works;
3. Overfill by the contractor, which resulted in material placed on the beach that was not accounted for in the measurement quantities.

3.3.4 Costs

The total cost of the works at Rosslare Strand amounts to £ 1.351 million (€ 1.935.000) approximately. The EU is providing some £ 385,000 (€ 550.000) towards this total. Irish Rail is contributing £ 220,000 (€ 315.000) in respect of its obligations to provide nourishment at Rosslare Strand. Approximately £ 375,000 (€ 540.000) is being provided by Wexford County Council. The balance, some £ 371,000 (€ 530.000) is being paid for by the Department of the Marine. The additional costs incurred by the Department on the ECOPRO project for tasks such as coastline monitoring, drafting of the sensitivity index and codes of practice and the project management tasks including design and monitoring of works are being absorbed by the Department.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

The beach nourishment has been completed in 1995 and has been surveyed on a regular basis, at least the year after the project was finished. From the analysis of this survey data to-date large variations in the average weather conditions over this period have resulted in significant sediment movement on Rosslare Strand. However for a proper assessment of the scheme ideally a number of years of post-completion monitoring and analysis to smooth out any temporal variations in weather patterns is required.

Immediately following beach nourishment and the artificial movement seawards of the high water marks the beach receded as the beach readjusted to a natural condition. Over the summer, accretion resulted in a large build up of the beach. However following persistent northeast to southeast winds between December 1995 and April 1996 large draw down of the upper beach occurred as material was removed to form a large alongshore bar approximately 200-230m seaward of the Direct Protection. This lowering of the beach resulted in the position of the MHWS waterline receding approximately 10-15m, to just seaward of its mean pre-nourishment position. This material forming the large alongshore bar is expected to be transported back onshore by calmer summer wave conditions.

4.2 Effects related to socio-economic aspects

The effects on the available beach area have so far been varying. During the summer a build up of the beach is occurring, however during the winter the water line has receded relatively far.

4.3 Effects in neighbouring regions

No effects were observed in neighbouring regions.

4.4 Relation with ICZM

The need for Integrated Coastal Zone Management (ICZM) is accepted by Government as a commitment in its Action Programme for the Millennium and the Department of the Marine and Natural Resources, as lead Department, is charged with preparing (after consulting all relevant Departments etc.) policy and legislative proposals for Government consideration. This very complex task which has an all-Ireland dimension requires time and resources. The Department of the marine and Natural Resources aims to make substantial progress in preparing such proposals in the first half of 2001.

In 1997, a Coastal Zone Management (Coastal Zone Management - A draft policy for Ireland, 1998) was drafted for Ireland. Due to lack of funding, gaps in legislation and lack of knowlegde 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.

EC funding is available for Rosslare through the ECOPRO project. ECOPRO-environmentally friendly coast protection — is a joint operation between a number of Irish bodies — Clare, Wexford, Waterford and Kerry County Councils, Coastwatch Europe, Eolas and the

Department of the Marine; a number of northern Ireland bodies — the Department of the Environment, the University of Ulster and The National Trust; and also the Danish Coast Authority. The objectives of the ECOPRO project are to assess the vulnerability of the coast to change, including erosion, to consider the need for protection and to examine the performance and environmental impact of existing coastal protection works, including a demonstration project. Rosslare Strand has been chosen as the Irish demonstration site.

The ECOPRO project will produce a methodology for future protection needs, a code of practice for the planning, installation and performance monitoring of low cost protection and a source of information for managerial purposes. ECOPRO encompasses the whole concept of coastal zone management, looking beyond individual projects and embracing the concept of comprehensive coastal planning. It is an excellent example of the close co-operation now taking place between the Department of the Marine and coastal local authorities in the planning and management of all aspects of the coastal zone.

4.5 Conclusions

Effectiveness

Information on the effectiveness of the coastal protection scheme at Rosslare, including six rock groynes and additional beach nourishment in the groyne bays, was only found for the first year after construction. In this short monitoring period, during the winter storm events, a long shore bar was formed with sediment taken from the beach. Thus, the coastline receded. However, it was expected that during the summer the beach would be rebuilt again. The long-term effects of the nourishment and groyne construction cannot be determined from such a short monitoring period.

Possible undesirable effects

No undesirable effects of the beach nourishments and groyne construction were observed.

Gaps in information

No information was found on the monitoring process after 1996, only the effects and results until one year after the construction of the coastal protection scheme are known. A more general effect analysis could be made if information is available over a longer time span.

5. REFERENCES

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Figures:

Figure 1: http://www.icm.noaa.gov/country/ireland.html
Figure 2: www.poirishsea.com/information/ ports/MapOfRosslareBig.htm
Figure 3: Environmentally friendly coastal protection, ECOPRO
Figure 4: Environmentally friendly coastal protection, ECOPRO
Figure 5: http://www.dfdsseaways.de/pd/entry.nsf/direct/de?OpenDocument&Display=detravel.nsf/W/T-Cuxhaven-Harwich-DerSdirland-Durchgangstarif
Figure 6: Environmentally friendly coastal protection, ECOPRO
Figure 7: www.coralgablesguesthouse.com/ activiti.htm
Figure 8: Environmentally friendly coastal protection, ECOPRO
Figure 9: myhome.iolfree.ie/~gavcos/ wexford.html