

Environmentally friendly coastal protection

The ECOPRO project

Brendan Dollard

Offshore & Coastal Engineering Unit, Enterprise Ireland

In the battle to preserve land against the ravages of the sea man has created many inappropriate protection structures on the coast. Often the coastline which is being protected is, inherently, in dis-equilibrium with nature. When combined with the increased recreational usage of the coastal zone, the rise in sea level and the increased incidence of storms, accelerated erosion rates are often the result. The Environmentally Friendly Coastal Protection project, or ECOPRO for short, developed a coastal erosion assessment method for the non-specialist. It devised a system for optimising erosion monitoring and developed a guide to select an appropriate coastal protection response. The project results are contained in the ECOPRO Code of Practice. Prepared by the Offshore & Coastal Engineering Unit of Eolas (now part of Enterprise Ireland), it is the result of four years of work which was supported under the EU LIFE Programme and drew on expertise

Introduction

In recent years it has become accepted that the coastline is a valuable natural resource which needs careful and sensitive management. This is especially so in the case of small island countries where the coastal zone has a direct and major influence on the economic welfare of the country. Coastal erosion has always been seen as one of the main threats to this resource.

In Ireland, following destructive storms in the late 1980's which caused severe damage and accelerated erosion rates, there was a perceived need to seriously address the question of coastal erosion. A National Coastal Erosion Committee, formed under the auspices of the County and City Engineers Association, produced a report in 1992 which concluded that a Coastal Management policy rather than a purely Coastal Erosion policy was needed. This report also recommended that 'A code of practice for coastal protection should be drawn up to ensure the uniformity and appropriateness of all works'[1].

Following an initiative by Eolas, the late Professor Bill Carter of the University of Ulster and The Department of the Marine, a proposal for a coastal protection and management demonstration project was successful in obtaining funding under the E.U. Life Programme. Managed by Eolas, the project team consisted of the Department of the Marine and a number of local authorities in the Republic of Ireland, the Department of the Environment and the National Trust in Northern Ireland, Coastwatch Europe, and the Danish Coastal Authority (Kystinspektoratet). Inputs were also sought from Universities in the Republic and Northern Ireland and from private firms with particular expertise in this field.

Project Objectives

The specific objectives of 'ECOPRO' were:

- To develop coastline monitoring methods which will be adaptable to various types of coastline.
- To develop a Sensitivity Index by which a coastline's susceptibility to erosion is graded.
- To present an assessment of performance of shoreline protection/management methods.
- To present a report on the design, construction and success of two types of protection methods at selected sites.
- To present all of the above as a 'Code of Practice'.

These five objectives form the five main tasks of the project. Each is dealt with in the final product of the project, the Code of Practice.

The overall aim of ECOPRO was to promote the use of soft engineering coastal protection techniques by firstly promoting a methodology which will allow the non-expert to assess the erosion problem and identify the likely causes. Secondly, it aimed to provide information on suitable coastal protection and management solutions with particular emphasis on environmental impact. Finally, the project intended to supply reference information on coastal processes and identify useful environmental and historical data sources.

Project Management

Eolas was the overall Project Manager and was responsible for its day to day activities. The project was directed by the Steering Committee which was chaired by the Department of the Marine. A Technical Group provided the Committee with technical analysis of its proposals and drew up specifications for project work. It also drafted the progress and interim reports of work in hand.

Tasks Undertaken

Coastline monitoring

The objective of this work was to devise and test various coastline monitoring methods in order to optimise the time and money spent in obtaining data on coastline and beach level fluctuations. Coastline monitoring can be divided into two complementary tasks, monitoring contemporary coastline change and ascertaining the historical evolution of the coastline plan.

Contemporary coastline monitoring

Coastline monitoring is vital in assessing the sensitivity of the coast to erosion. Beach levels and sediment size data, for example, are invaluable as a means of validating and fine tuning sediment transport computer models so that the erosional trends evident in the necessarily short measurement periods can be extrapolated to much longer time spans.

Seven sites were chosen for detailed study and are shown in Fig. 1. Each has a distinct soft coast and suffer from differing types of erosion. The methods used by ECOPRO to monitor beach and nearshore change were;

- beach profile measurement (standard levelling and total station)
- height contour extraction from ortho-photography
- beach level measured at 'Cut-down' posts (metal post with sliding plate permanently positioned on the beach)
- beach level measured at existing fixed points (rocks, piers, etc.)
- dune cliff/toe position monitoring
- nearshore hydrographic surveys
- sediment size sieve analysis

The complete ECOPRO coastline monitoring dataset contains;

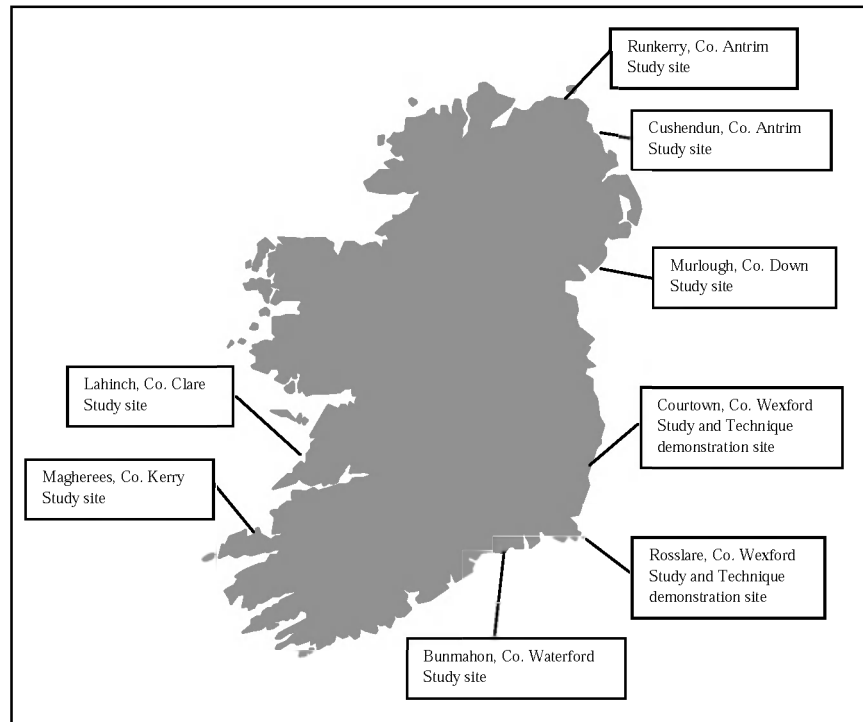


Fig. 1. Location of ECOPRO study and technique demonstration sites

- 8 sets of 70 beach profile cross-sections taken approximately every two months from October 1993 to March 1996
- height contour data from commissioned aerial photography for one site
- 30 sets of 20 beach monitor post data taken approximately every month
- wave hindcast data for 4 points offshore Ireland covering a two year period (3 hourly readings of wave height, period and direction for wind waves, swell waves and resultant waves)
- digital imagery (full spectrum and infrared) from aerial and video photography for 60 km of soft coast.
- hydrographic survey data for four study sites

The bathymetry at a fifth site was measured on a regular basis to aid with the Sensitivity Index computer studies. Sediment sampling was carried out at the four Republic of Ireland sites. One of the Northern Ireland sites was regularly sampled, again as part of the Sensitivity Index work.

- historical ground survey data

In carrying out a historical comparison the choice of base map affects overall accuracy of the study with, for example, the transfer of information from 1:10,000 aerial photographs to 1:25,000 maps resulting in loss of Ascertaining the historical evolution of the coastline



Fig. 2. Coastline evolution at Courtown, County Wexford

In addition to the current fluctuations of the beach the longer evolutionary trend of the coastline plan can be determined by comparing its position at different times. There are a number of sources which can be used to fix the coastline's present and historical position such as;

- Ordnance Survey maps
- hydrographic charts
- aerial photographs (film and digital CIR)
- historical ground survey data

In carrying out a historical comparison the choice of base map affects overall accuracy of the study with, for example, the transfer of information from 1:10,000 aerial photographs to 1:25,000 maps resulting in loss of information. On the other hand the transfer of information from the same photographs to 1:2,500 scale maps may give the impression to the end-user that the information is more accurate than it actually is. For coastal change analysis maps from the 1:10,560 series have the advantage in that at least two maps exist for all areas of the country from different surveys. The most recent revised 1:10,560 map available is from 1952 (for Clare) while most areas have a most recent survey from the 1920s. The 1:2,500 scale series is more recent but may be too detailed in some instances for a county-scale study. The 1:25,000 and the 1:50,000 scale maps are perhaps not detailed enough.

The most critical coastline feature to be extracted are the coastal vegetation line in dune areas and the cliff top and base lines on rocky coast. The advantage of using these features as opposed to tidal lines i.e. HWM, LWM, is that the information can be derived from both maps and aerial

If conducting a large scale survey, the cliff base line may be the preferred reference line in cliffed areas. If the survey is local, the cliff top is more easily located on site by measuring from field boundaries and other fixed features and can be related to O.S. maps and aerial photographs.

The ECOPRO historical dataset contains four volumes of historical erosion data covering four of the study sites. Each contains all available maps and aerial photography along with reports from national and local sources.

ECOPRO opted for a custom built coastal data storage and display system SANDS (Shoreline and Nearshore Data System). Three packages were initially installed in the Department of the Marine, Eolas and the Department of the Environment, Northern Ireland and later one copy was transferred to a Local authority in order to determine its suitability for local data storage and analysis.

The analysis of the data collected has provided ECOPRO with the practical knowledge necessary to be able to optimise the choice of monitoring technique for a particular erosion problem. These recommendations are included in the Code of Practice and details of the techniques are given in the Code appendix. The data was also used by the Sensitivity Group in their work on the Sensitivity Index.

The Sensitivity Index

The objective here was to gather together as much information on the factors that influence coastal erosion and 'weight' them according to the historical sensitivity of sections of the coast to erosion. Based on these, a general erosion 'sensitivity index' system was to be developed.

The background to this work was a paper written by V. Gornitz [2] who developed a simple scoring system which could be used to determine the vulnerability of coast to erosion. It was intended to be used on a large scale for isolated areas where it was not feasible or economical to collect accurate

data. However, the technique produced ECOPRO was not considered appropriate for the target users of the code, as, for it to be sufficiently accurate, computer modelling of nearshore wave transformation would be required [3]. Fig. 3 lists the variables typically involved in coastal erosion.

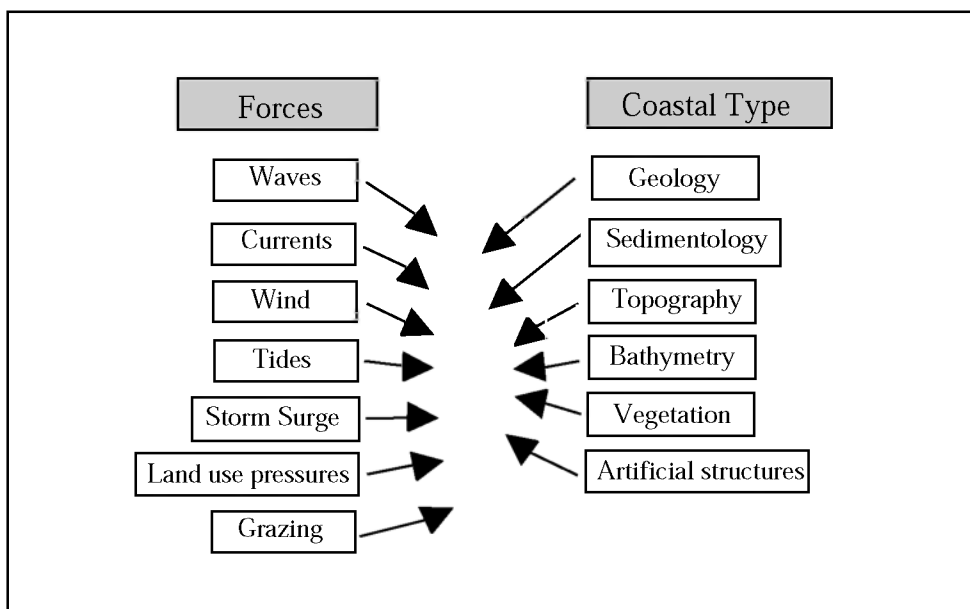


Fig. 3. Variables involved in coastal erosion
photographs. Use of HWM and LWM obtained from O.S. maps is considered unreliable for accurate coastline change analysis. An example of the historical change of the coastline at Courtown Co. Wexford is shown in Fig. 2.

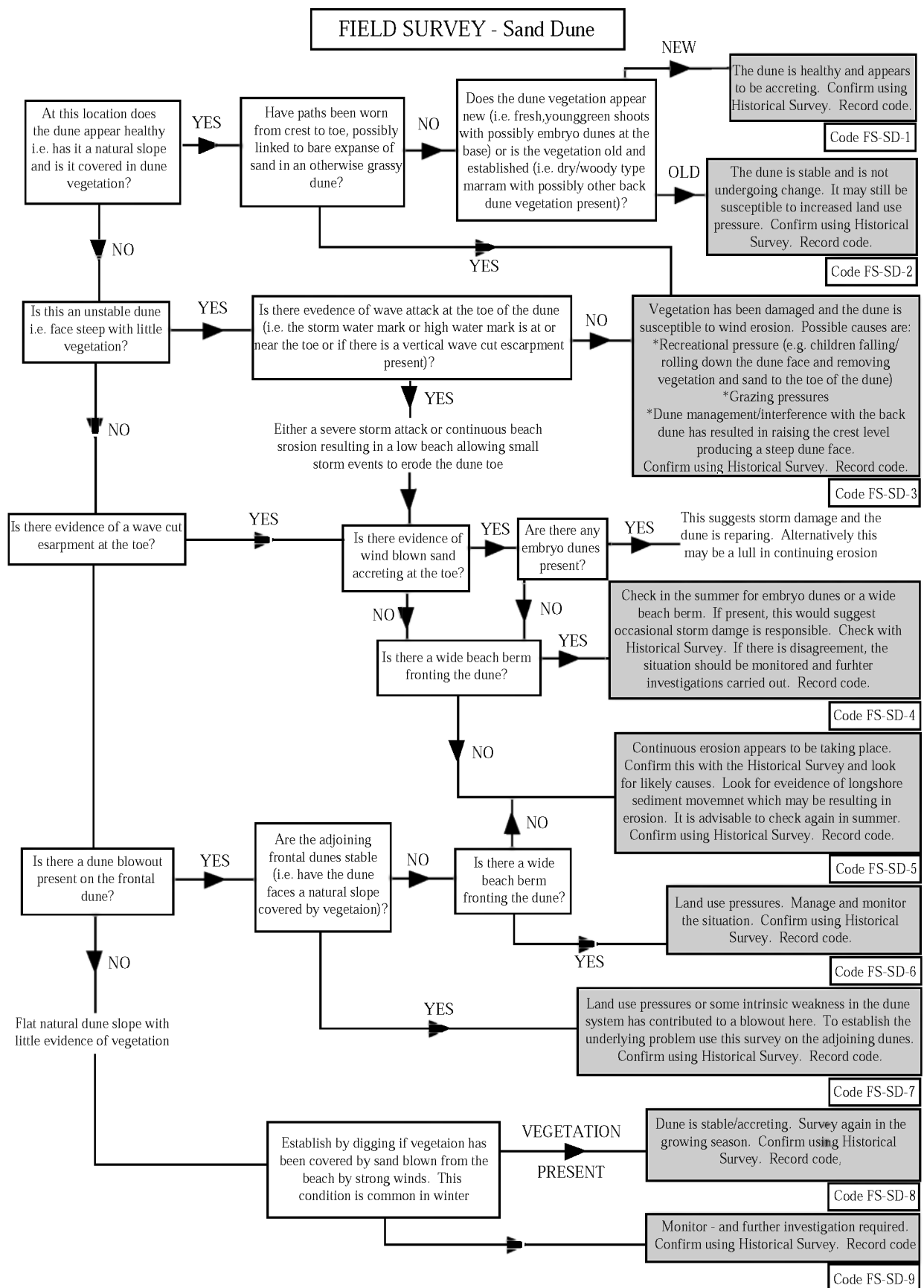


Fig. 4. Example of decision support flowchart from field

The purpose of developing the index was to provide the non-specialist with a method of assessing the vulnerability of the coast to erosion and to help identify its causative factors. For the Code of Practice it was decided to develop a technique using Field and Historical Survey decision support flowcharts. The result is a user friendly and practical approach to a complex problem and trials conducted by non-experts using the flowcharts have helped the ECOPRO team to refine the technique. Initial results are very encouraging but it is only when the method is more widely used will its full potential be realised. An example of one of the flowcharts is shown in Fig. 4.

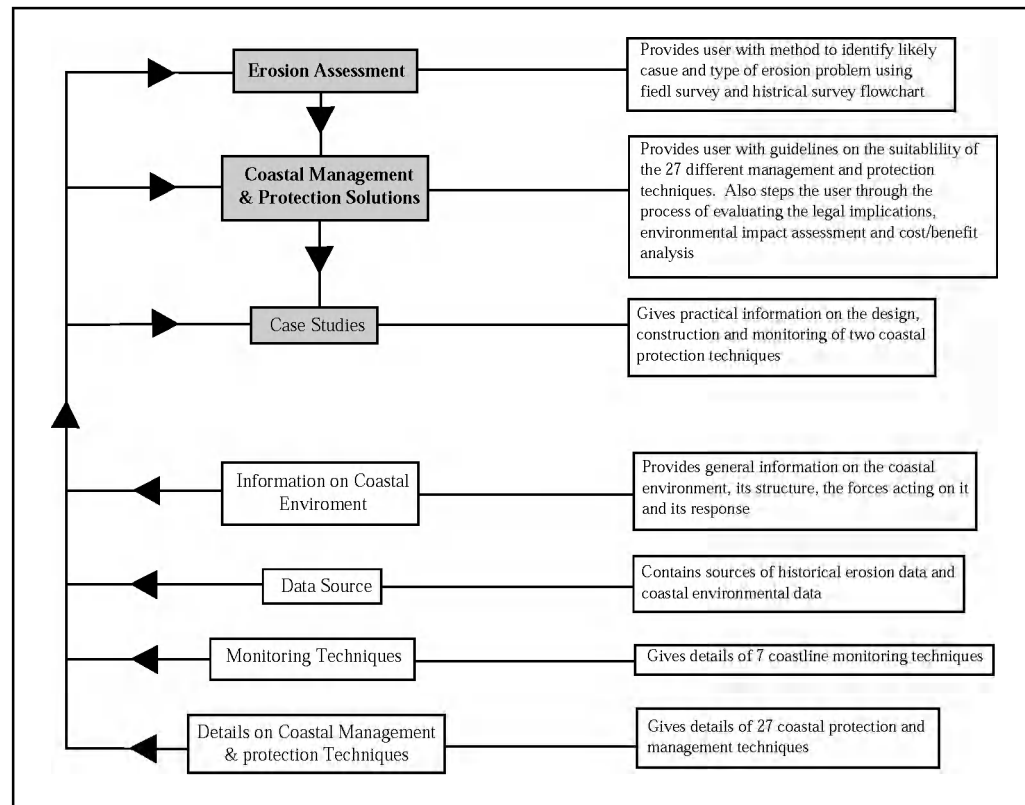


Fig. 5. Code of Practice

required, hard structures may be necessary. General information on these and their likely impact on the environment is given in the Code of Practice.

Evaluation of coastal protection / management options

The objective of this task was to examine current coastal protection measures being used and to evaluate their success. Each technique was to be summarised and included in the Code of Practice.

Following from the results of a literature survey and a questionnaire circulated to all the local authorities in Ireland and in Denmark, ECOPRO identified twenty seven different coastal protection and management techniques. Details on each are included in the appendix of the Code where guidelines on their suitability are also given.

ECOPRO advocates the use of soft engineering options wherever possible. These attempt to work with natural processes rather than oppose them. This approach often means that the shore zone is used as a buffer and must be wider than would be envisaged under conventional hard engineering schemes. An environmentally friendly scheme must often consider a certain amount of erosion as being beneficial, providing sediment interchange along the coast.

Many of these soft engineering techniques are not suited to exposed 'high energy' coastal areas where large waves impinge on the coast. Here, if protection is absolutely

Case histories of protection techniques

The objective here was to provide practical information on the design, implementation and monitoring of two different types of environmentally friendly coastal protection techniques.

One of the projects covered was a beach nourishment scheme in Rosslare, Co. Wexford. Here 160,000m³ of sand, dredged from offshore bars, was placed on the beach. This is the largest beach nourishment scheme carried out in Ireland to date.

The second was a small scale scheme involving the re-contouring of a sand dune ridge, marram grass planting and dune toe protection in Courtown, Co. Wexford.

These two techniques are possibly the most popular soft engineering methods employed in Europe today. Practical information on both is included in the Code of Practice.

The ECOPRO Code of Practice

The Code of Practice is the final product of ECOPRO and whether it achieves its aims of increasing the awareness of the fragility of the coastal environment and preventing mistakes being made with coastal protection measures, will be the true result of the project. The Code of Practice follows a logical step-by-step path guiding the user through the assessment and solution of an erosion problem and the layout of the code is shown in Fig. 5.

General information on the coastal environment, contained in the appendix, is applicable, not only to North Atlantic coasts, but to most European Community waters. This section is also written in a clear style aimed at the non-expert. Formulae are only included where necessary and are usually backed up with graphic illustration.

The Code is available from the Government Publications Sales Office in Molesworth Street, Dublin.

sion between the North and South of Ireland and Denmark helped to broaden our perspective. A successful visit to Denmark by the ECOPRO members, where a number of soft engineering coastal protection methods were viewed, was also very beneficial.

This Code of Practice should be of considerable use as a guide to current best practice on coastal protection and management. It is hoped that it will avoid the instant palliative response to storm damage and also ensure that those involved in coastal protection first look at the soft engineering techniques. It is not intended that the code would attempt to supplant the technical manuals on the subject of coastal protection as it is not aimed at the coastal engineer. It is instead, to be used by the non-expert and, it is hoped, will help them to avoid making mistakes in their response to coastal erosion. In addition the code aims to make the non-expert more aware of the fragility of the coastal environment and how complex and interrelated is the problem of coastal erosion.

Conclusions

The collaboration on the project between the Universities, Government and local authority personnel and public volunteers was excellent and the multi-disciplined mixture of scientists, engineers and environmentalists ensured that most viewpoints were aired. The international dimen-

Acknowledgements

The author would like to express his gratitude to the European Commission, DGXI, for the financial assistance and encouragement given. My appreciation is also extended to the ECOPRO project team who worked tirelessly to make the project a success.

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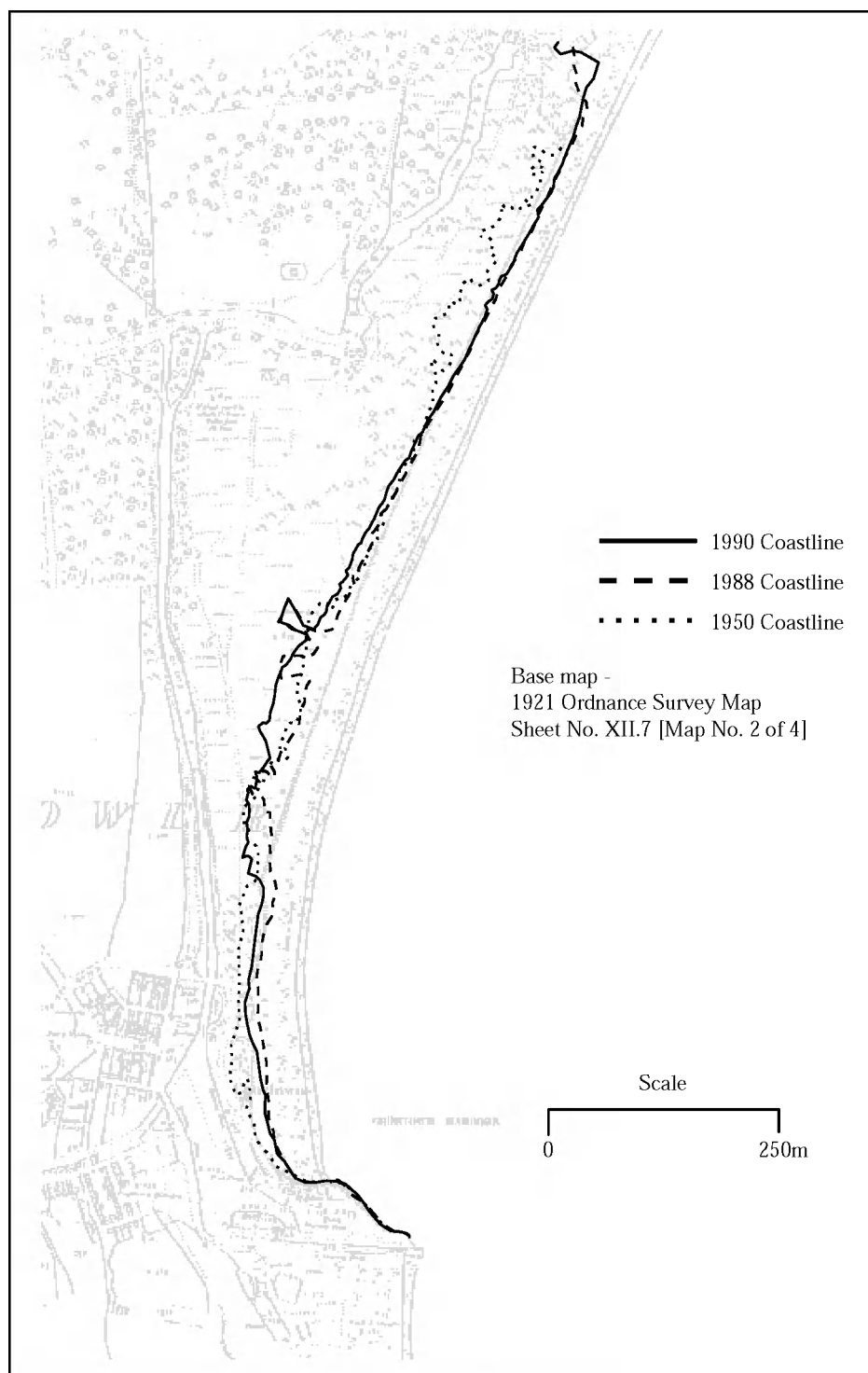


Fig 2 - Coastline evolution at Courtown, Co Wexford