

CHAPTER 233

Cost-benefit analysis of Shore Protection Investments

Luis Felipe Vila Ruiz⁽¹⁾
Fernando Bernaldo de Quirós⁽²⁾

Subject 2: Coastal processes: Shore protection

0.- Abstract

The paper describes the methodology established in Spain to assess shore protection investments. The method consists of two phases: a pre-assessment based on physical and economic indicators and an assessment in which the financial, economic and social appraisals are estimated using cost-benefit analysis techniques.

The paper also contains the preparatory works to create a data-base necessary to establish a demand-modelling.

1.- Introduction

The Spanish coastline is 7,883 km long, and stretches along 10 of the country's 17 Autonomous Communities. 4,990 km correspond to the Peninsula and 2,893 km to the Balearic and Canary archipelagos and to Ceuta and Melilla.

The 478 coastal towns have a permanent population of 14 million inhabitants, approximately 35% of the population of Spain, in a 36,252 km² area, 7.2% of the total area. This means that in the coastal towns, population density is 5 times greater than the national average.

⁽¹⁾ Asesor del Director General de Costas. Ministerio de Obras Públicas, Transportes y Medio Ambiente. P^o Castellana, 67 - 28046 Madrid (España)

⁽²⁾ Presidente de TEMA GRUPO CONSULTOR,S.A. Avda. de América, n^o 37, 1^a planta - 28002 Madrid (España).

It is estimated that international tourism will bring 60,000,000 visitors and about 40,000,000 tourists to Spain in 1994. The majority of this tourism (over 80%) is conventional sun and beach tourism. If national tourism is added to this conventional international tourism, the conclusion is, that in the peak period, population density in the coastal areas is 1,000 inhabit/km², about 12.5 times the national average.

Tourist production in Spain comprises between 8% and 9% of the GNP.

Various reasons, among them town-planning pressure from fixed population settlements and the need to provide the coastal area with sufficient tourist capacity, have meant that between 1960 and 1980 the Spanish coast has rapidly deteriorated.

This deterioration and greater awareness of the population to environmental issues has created a desire to change the existing situation, by establishing a shore protection policy and regeneration of the already deteriorated shore, so that current and future generations will benefit, (sustainable development) and so that the quality of the environment is improved.

This desire for a change has been reflected in various actions.

- More and more shore investments, which have gone up from 225 million pesetas in 1979 to 19,766 million pesetas in 1993. (FIGURE 1)
- The enactment of a new Coast Law in 1988, which in the explanatory preamble stated: "Apart from a clash of interests on many occasions for land and sea public property, the overriding idea of this law is twofold: To guarantee its public character and conserve its natural characteristics by reconciling development demands with protection requirements."
- Preparation of an analysis, planning and appraisal method on shore investments from 1987.
- Writing of a 1993-1997 Coast plan.

The basic aim of the present document, is to describe the studies which the National Coast Office has conducted in recent years to rationalise planning and shore investment appraisal, so that, as mentioned earlier, sustainable development is maintained and shore protection and cost-effectiveness of investments is ensured.

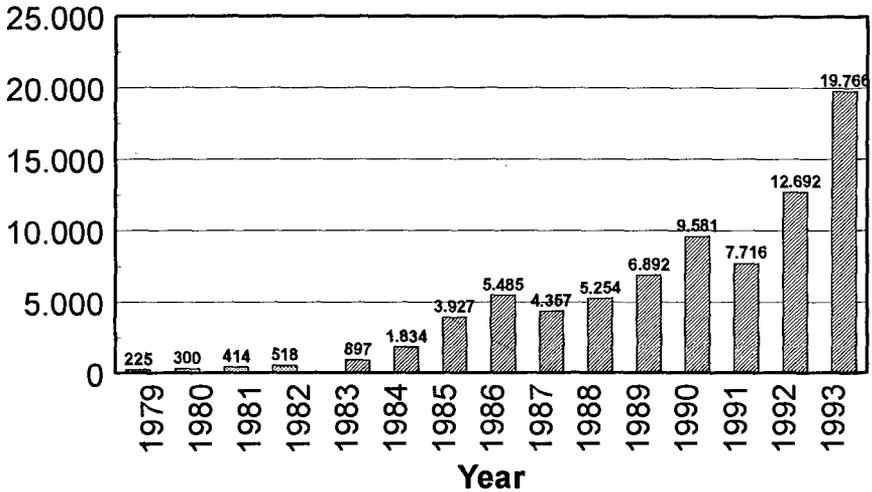
Millions of pesetas

Figure 1. Investment evolution at the coast

2.- Description of the Cost-Benefit Analysis Method of Shore Protection and Utilisation

There were various reasons for establishing a method for appraising shore investments, in line with other public sector investments.

- A sharp rise in shore investments from 1983.
- Achievement of a rational and uniform method for comparing and selecting shore investments, since the financing of these investments compete with others also within the realms of the Budget.
- Correct sizing of the investments to be undertaken and determination of their order of priority, according to the benefit expected.
- Promotion of natural resources development in the shore environment, deteriorated in some areas, as a major factor in the economic development of the adjoining areas.

- Protection of the coastal environment and its regeneration in deteriorated areas.

This method has been developed in various studies, some theoretical, and others practical, with the compilation of basic information. The main studies are summarised below.

2.1.- The Manual on investment appraisal

In 1987, the first study was prepared "**Study on the appraisal of the social and economic effect of investments**". This study, theoretical in nature, began with a bibliographical search and it showed that there were hardly any records on this type of work. **Using the scant references found and the basic principles of optimal resource allocation, the fundamental guidelines were drawn up for a shore appraisal investment methodology.**

In 1989, and taking as the starting point the results from the previous study, a "**Manual on shore investment appraisal**" was written.

In this Manual three types of appraisals were established:

- **Financial appraisal:** It quantifies the effects of shore investments on public sector revenue and expenditure, as promoting the area of public land and sea property.

The most relevant items of cost and revenue are considered to be:

- On the cost side, are land cost, investment cost and variations in conservation and operating costs between situations "with and without" investment.
- On the revenue side, are the variations which occur with the collection of taxes for economic activity between the two aforementioned situations, as well as the variation in revenue from the Administration's operating of public services.

In order to calculate revenue and expenditure variations, it is necessary to **estimate the number of users** of coastal facilities, **using mathematical models to forecast demand**, and **average expenditure per user** on the various facilities.

In the financial appraisal, costs and revenue are assessed at market prices. Comparison of revenue and cost flows, for the time interval under analysis, means that traditional cost-effective investment appraisal indicators can be established, using the updating technique: **updated net benefit, cost-benefit ratio,**

internal rate of return, etc.

- **Economic appraisal:** Generally, in this appraisal the viewpoint adopted is that of the community. Therefore, the main effects under consideration are:

- As benefits, **variation of user and business surpluses between the situations "with and without"**. The main components of user surplus are the variations in the level of satisfaction as a result of the variation in quality and capacity of the beach (or the coast, in general) installations and facilities, variation in security and possible improvement in accessibility.

The business surplus is calculated for all the agents concerned and, in particular, for building Companies in the investment execution phase, and for service-lending Companies and owners of property or premises revalued by the investment, in the operating phase.

Cost components are basically the same as the financial appraisal components, although it has to be borne in mind that in the economic appraisal resource prices must be assessed in terms of opportunity cost, **or in terms of the highest value than at the moment of analysis which could result from alternative use** of these resources. This requires the corresponding adjustments of market prices and, in particular, removal of taxes which are only transfers between economic agents.

As for the financial appraisal, the habitual cost-effective indicators can be obtained in the economic appraisal.

- **Social appraisal:** This appraisal aims to measure what each investment project contributes to the general social aims. The most important of these aims are the following:

- Generation of employment, both in the investment execution phase and the operating phase.

- Redistribution of income. This effect can be considered as giving a greater weight to the benefits perceived or the costs borne by the lowest income groups, establishing weighting coefficients for different income levels.

- Protection and environmental improvement. The following can be considered:

- .. quantifying possible harmful effects of investment by the cost of the measures essential for avoiding them,

- .. estimating the cost of other alternative and essential actions for achieving the same beneficial effects on the environment which, in this instance, stem from the shore investments under analysis, or
- .. giving a monetary reference value to the property to be protected or improved (for example, monetary value attributable to a hectare of dunes or marshes).

2.2.- Database of beach supply and demand

The systematic application of an investment appraisal process on shore protection and utilisation requires, as has already been stated, other information such us:

- calculation of the demand for coastal installations and facilities and
- estimation of user unit expenditure.

This information is absolutely essential for investment in beaches.

For this reason, when the Method and Manual on shore investment appraisal had been prepared, a **Plan for recording data and surveys was established, with the intention of achieving a time series which** would facilitate the aforementioned estimates for different situations.

This campaign for recording data has been developed during 1990, 1992, 1993 and 1994 and a computing device has been designed for the inclusion and processing of annual data in order to have a sufficiently reliable chronological sequence.

The information collected every year is basically threefold:

- **Number of beach users.** Counts are done on a sample of beaches on working days, Saturdays and holidays, chosen randomly during the summer months (normally July, August and September).
- **Characteristics and user behaviour patterns.** Surveys are conducted, during the summer months, to a sample of users, who are asked for details on: nationality, length of stay, type of accommodation, length of time and means of transport from the summer abode to the beach, frequency of beach use, rating of beach quality, income group, amount spent on the main items (accommodation, beach services, transport, etc).
- **Data on beach supply.** These data refer to:

- Natural characteristics of the beach and its surroundings: beach plan, length, width, area, slope, sand type, quality of the water, rainfall, average temperature, wind system, sunshine hours, etc.
- Beach installations: Showers, changing rooms, WCs, sunbeds, parasols, promenade, car parks, etc.
- Town facilities: Town plan, hotel and other accommodation capacity, restaurants, bars, scenic view and surroundings, entertainment and recreation facilities, etc.

2.3.- Modelling of user demand

The models which have been used to explain the current demand for beach use and, mainly, to estimate future users for various beach characteristics and facilities include three types of variables:

- **Variables representing beach characteristics.**
- **Variables measuring potential users.**
- **Friction variables**, linked to the cost and the time it takes to get from the summer abode to the beach.

a) As regards the variables **representing beach characteristics**, on the one hand, ratings have been included on the beaches from the surveys to users and on the other hand, general beach characteristics have been included. The latter could possibly affect rating: length, width, promenade length, sand quality, number of showers, WCs, parasols, changing rooms, etc.

To avoid constantly having to conduct surveys to users on beach rating, for every possible investment study, and since it is impossible to conduct surveys on hypothetical future situations of the beach in question, preparation of a mathematical model beforehand has been considered instrumental for rating the beach. The dependent variable has been taken as the rating given by users to the beaches under study and independent variables as the general beach characteristics mentioned above.

After various trials and errors, the adjusted model corresponded to the formula:

$$R = e^{1,4973} \times Wid^{0,016928} \times Prom^{0,010299} \times Nat^{0,3083} \times WC^{0,008848}$$

where:

R = beach rating

Wid = average width of the beach, in metres

Prom = quotient of the length of the promenade by the length of the beach

Nat = sand nature and quality (1, 2 or 3)

WC = no. of WCs per km of beach, with a correlation coefficient $r = 0.82$

b) Consideration of **variables representing potential users** has meant it has been advisable to conduct two model demand groups:

- for permanent resident demand, the representative variable has been taken as the population of adjoining towns,
- for tourist demand, the variable of hotel and other accommodation beds on offer multiplied by the occupation rate has been considered.

c) **Inclusion of variables representing the cost of accessibility to the beach, as a dissuasive factor** forces the models to be adjusted in line with the resident population, or the variable of hotel and other accommodation beds multiplied by the occupation rate, according to distance intervals, giving each interval an average value.

Bearing in mind these considerations, the adjusted models correspond to the formulae:

- For resident users:

$$U = 0,9385 \times P^{0,7531} \times R^{1,19506} \times D^{-0,51139}$$

- For habitual non-resident tourists:

$$U = 1,5018 \times P_t^{0,25030} \times R^{3,82106} \times D^{-0,47245}$$

In these formulae,

U = no. of users on an average day of the season considered.

P = resident population, in the distance interval of D average value.

D = average value of each distance interval considered, in metres.

R = beach rating, according to the model mentioned in section a).

P_t = hotel and other accommodation places multiplied by the occupation rate.

The correlation coefficients are low in both cases, $r = 0.64$ for residents and $r = 0.58$ for tourists. Better results can be obtained by breaking down the models into: months, beach type, working days, Saturdays or holidays, etc. However, not enough data on the chronological sequence available meant these breakdowns could not be done in 1992 when these models were adjusted. Currently, we have the 1993 data and, shortly, we shall be having the 1994 data, then it will be possible to readjust and break down the models.

In addition to this readjustment, the models need to be made more sophisticated, so that it is possible to determine where new users have come from for the additional demand in response to improved beach characteristics and services. User type distinction is as follows:

- "Generated" users, that is to say, who previously did not use any other beach.
- "Captivated" users from another overcrowded national beach.
- "Captivated" users from a non-overcrowded national beach.
- "Captivated" users from other foreign beaches.

In fact, this distinction is vital, for financial, economic and social appraisals. It can be done, either by breaking down the models further into generated or captivated user type, or by developing a global model for analysing user deviation among the group of competing beaches. This is a line of research to pursue, coupled with extension of the supply and demand Database chronological sequence.

2.4.- The determination of planning indicators

Application of the appraisal method established in this Manual, on the one hand, is aimed mainly at beach investments and, on the other hand, requires a technical project of the actions to be conducted and a relatively laborious appraisal process, especially while there is no database for a sufficient number of years.

All this implies costs and analysis time which would be unjustified if, in the end, the investment were not considered to be financially, economically or socially profitable. This risk will tend to be even greater where the most obvious cost effectiveness investments have already been made.

Therefore, a study is currently being developed for designing a set of indicators with the following aims:

- to have a rapid appraisal tool in keeping with the Manual, although less polished,

- to compare "grosso modo" alternative actions,
- to establish acceptable investment ceilings for various types of actions,
- to establish criteria and prepare indicators for measuring variation in user "satisfaction", as a result of various actions on the coast,
- to include measures of the effects on protection and improvement of the environment,
- to establish indicators not only for beach actions but for the rest of the shore.

With this in mind, a preliminary list of types of actions has been prepared for: beach regeneration, building of promenades, building of paths for coastal areas difficult to get to, protection of wall enclosures, protection and regeneration of dunes, building of seawalks, protection of cliffs, installation of recreation areas, preparation of areas for shallow or underwater fishing, water sports facilities, etc.

For each of these actions, the basic and ancillary aims pursued will be established and depending on these aims, the indicators for measuring their level of achievement will be prepared.

Since the study is still in the execution phase, it is not possible, for the time being, to advance any results. However, the intention is to establish a double entry matrix for action and aim typology, and the indicators to be calculated are defined in each intersected box in order to measure physical or monetary contribution of each type of action to each specific aim. **Considerable effort is being given to defining the aims precisely so that it is possible to quantify the level of achievement.**

For monetary indicators, average unit values will be established for each type of action and effect which can be assessed in monetary terms.

It is thought that the preliminary appraisal process should be completed by applying a multicriteria appraisal method in order to achieve an operating synthesis.

2.5.- Theoretical scheme of the shore action planning process

Bearing in mind the studies conducted, experience obtained and the works in progress, a theoretical scheme of the shore action investment planning process could be the one represented in the following chart. **(FIGURE 2)**

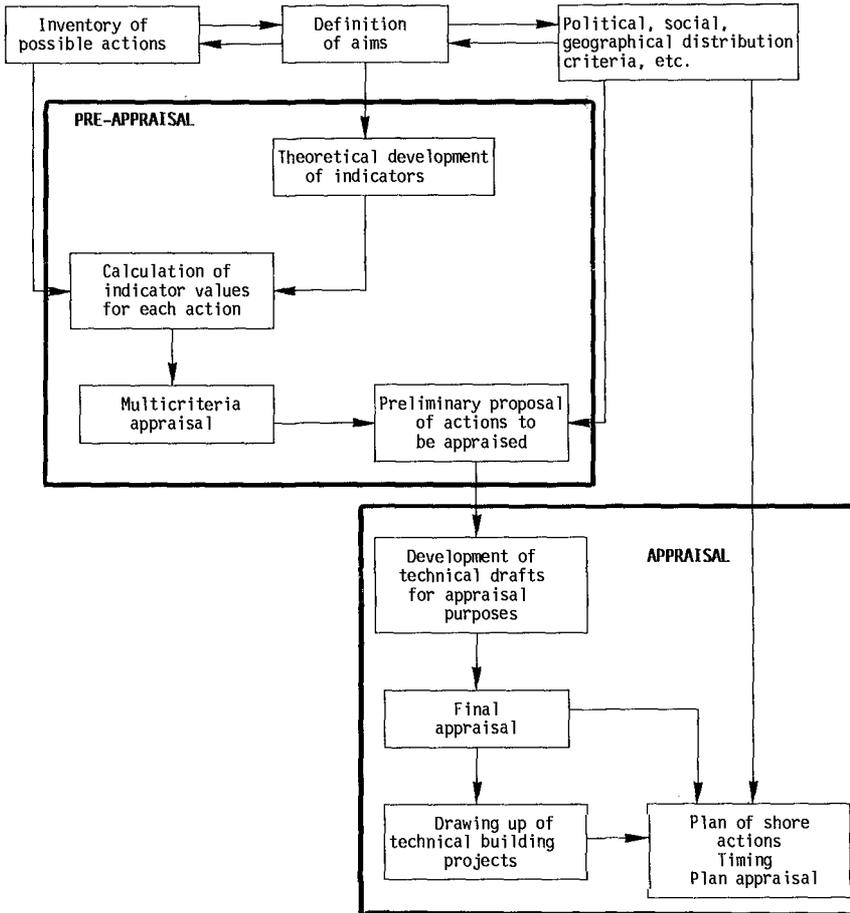


Figure 2

This chart illustrates that, beginning with political criteria and aims and knowledge of the shore, a relatively extensive inventory of possible shore actions can be established.

A pre-appraisal process is applied to this inventory, based on the establishment of indicators, and definitions of actions from a previous study. As a result of this pre-appraisal, a set of actions, probably viable from a technical and economical point of view, are selected and these are thoroughly analysed and appraised and the other remaining actions are discarded.

In the final appraisal phase, those actions selected in the first instance are defined more precisely by preparing the corresponding preliminary project and, the appraisal is made using the information in this preliminary project and the appraisal method in the Manual on shore investments is followed. The corresponding building projects are drawn up for the actions selected in the second phase and the execution of these projects are scheduled depending on their order of priority.

3.- Some actions implemented and Cost-Effective values obtained

Below are some examples of actions which have been implemented or are in progress, and the basic features of these actions and the cost-effective values obtained.

- Regeneration of the Pedralejo beach (Málaga)

Located in a modest district in the east of Málaga, with houses close to the sea. The beach has been regenerated with two free-standing breakwaters, two breakwaters in a Y shape and a breakwater with a flap to the west, and sand has been brought in. The already existing small fishing houses have been considerably revalued.

Investment: 489 million pesetas (M pt), at market prices

Financial appraisal: Updated net profit UNP = 71 M pt.

Cost-Benefit Ratio C/B = 1.15 **Internal Rate of Return** IRR = 7.37%

Economic appraisal: UNP = 1,322 Mpt C/B = 3.7 IRR = 42.7%

Social appraisal: UNP = 1,496 Mpt C/B = 4.06 IRR = 50.30%

- Regeneration of the Maresme: Premiá del Mar-Mongat (Barcelona)

The beach has virtually disappeared with the building of the Port of Arenys del Mar. Regeneration of the beach, about 7 km long, has consisted of building a breakwater and bringing in about two million m³ of sand.

Investment: 972 million pesetas (M pt), at market prices

Financial appraisal: Updated net profit UNP = 238 M pt.

Cost-Benefit Ratio C/B = 1.25 **Internal rate of return** IRR = 8.63%

Economic appraisal: UNP = 2,314 Mpt C/B = 3.38 IRR = 29.01%

Social appraisal: UNP = 2,678 Mpt C/B = 3.75 IRR = 33.45%

- **Regeneration of Magalluf beach (Balears)**

Located at the western end of the bay of Palma de Mallorca, with an impressive hotel infrastructure, which causes massive overcrowding on this narrow stretch of beach.

136,000 m³ of sand were brought in to a cove between two projections and naturally protected from the force of the waves by an existing island.

Investment: 176 million pesetas (Mpt), at market prices

Financial appraisal: Updated net profit UNP = 3656 Mpt.

Cost-Benefit Ratio C/B = 21.78 Internal Rate of Return IRR = 122.02%

Economic appraisal: UNP = 8,442 Mpt C/B = 48.97 IRR = 248.1%

Social appraisal: UNP = 7,991 Mpt C/B = 46.41 IRR = 241.7%

- **Regeneration of La Laja beach (Las Palmas de Gran Canaria)**

The aim of this regeneration is to provide Las Palmas with a beach for decongestion of Las Canteras beach. This has consisted of building two dikes, tipping 400,000 m³ of sand, remodelling a promenade for cars and building a complex with cafeteria and public conveniences.

Investment: 835 million pesetas (Mpt), at market prices

Financial appraisal: Updated net profit UNP = -848 Mpt.

Cost-Benefit Ratio C/B = -0.02 Internal rate of return IRR = -11.04%

Economic appraisal: UNP = -272 Mpt C/B = 0.67 IRR = 1.53%

Social appraisal: UNP = 37.2 Mpt C/B = 1,04 IRR = 6.59%

- **Regeneration of the Gross beach in San Sebastián (Guipúzcoa)**

The aim is to provide the Gross district in San Sebastián with a stable beach, even at high tide, in order to reduce overcrowding on La Concha and Ondarreta beaches. Actions have consisted of prolonging the channelling of the River Urumea, the tipping 1,100,000 m³ of sand and building a promenade and beach services. The regenerated length is about 900 m.

Investment: 2,773 million pesetas (Mpt), at market prices

Financial appraisal: Updated net profit UNP = 684 Mpt.

Cost-Benefit Ratio C/B = 1.25 Internal rate of return IRR = 9.03%

Economic appraisal: UNP = 4,833Mpt C/B = 2.74 IRR = 27.45%

Social appraisal: UNP = 4,833Mpt C/B = 2.74 IRR = 27.45%

- **Regeneration of the stretch of the shore Peñíscola-Benicarló**

This has consisted of extending the current 1,800 m of beach next to the town of Peñíscola towards the north, as far as Benicarló. It is about 6 km long and about 70 m wide. Planned actions are: reinforcement of the coastline, building a promenade, detour of the road towards the interior and tipping of sand.

Investment: 3,391 million pesetas (Mpt), at market prices

Financial appraisal: Updated net profit UNP = 4,572

Cost-Benefit Ratio C/B = 2.35 Internal Rate of Return IRR = 17.46%

Economic appraisal: UNP = 13,399 C/B = 4.95 IRR = 37.85%

Social appraisal: UNP = 16,160 C/B = 5.77 IRR = 43.59%