CHAPTER 222

BEACH MONITORING PROGRAM OF VALENCIA (SPAIN)

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Abstract

The littoral processes and long-term shore protection plans are analysed for the coast of Valencia (Spain). The breakwaters built during this century by the Port Authorities have gratly affected the most Southern beaches by interrupting the natural longshore sand transport. The monitoring program of the beaches of Valencia (Spain) has been established for a precise estimation of the evolution in time of the beaches to the North and South by the Port of Valencia. Periodic topographic surveys provide the basic time-dependent beach description of the area. The two main objetives are the following: **a)** 3-D description of the beach surface, including estimation of reliability and measurement errors of bathymetrics, and **b)** stochastic description of wave climate.

High precision and cost-efficient beach surveying techniques have been developed during the monitoring program of the beaches of Valencia (Spain). Beach profiles and zero-shorelines have been obtained with systems and errors similar to the terestrial topography. The methods are simple enough to be applied by general land surveyors with a minimum training and may be extended to a variety of beaches for systematic and low-cost monitoring programs.

Introduction

Most beaches of the Gulf of Valencia in Spain suffer an erosion/acretion

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processes induced by inappropiate constructions and unadequate coastal policies. The rivers and the natural littoral sand drift created more than a hundred miles continuos natural sand beach which has been altered in several points by breakwaters, jetties, comercial ports and marinas. According to Yepes (1995), economic, social and political presures and different kind of lobbies are interacting on the sand beaches, which are considered the most critical production factor of the touristic sector in Valencia (10% of the Spanish GNP).

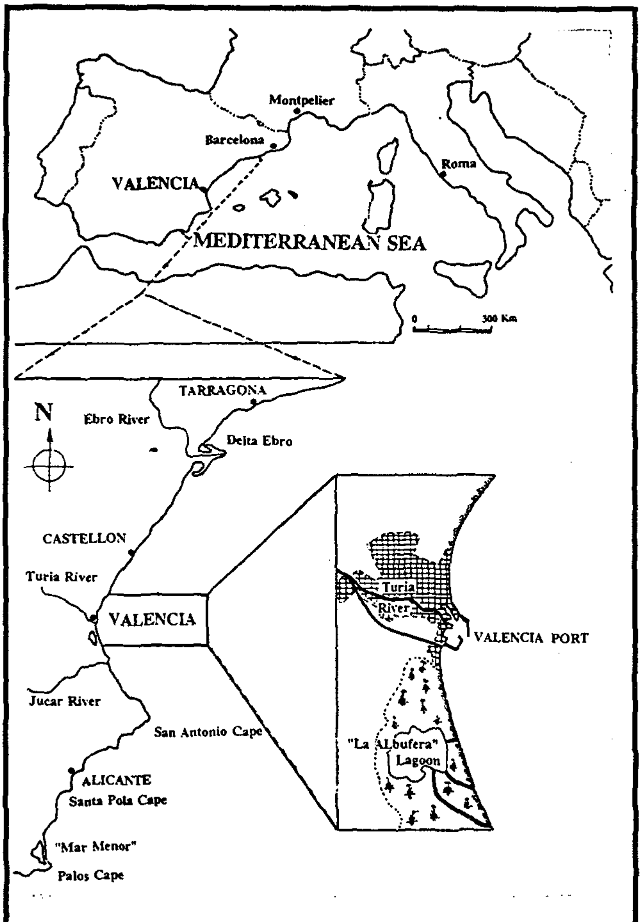


Figure 1. Gulf of Valencia and Area of Study

Cost-efficient beach monitoring programs appears as key elements in developing appropiate shore protection and beach nourishment plans. A high precision low-cost beach profile system developed during the monitoring program of Valencia (see Medina and Serra, 1993) is being applied for beach monitoring North and South of Valencia and may become a common low-cost system for autonomous and descentralized control of beaches along the Spanish Mediterranean coast

Environmental Characteristics

Figure 1 shows the location of the area of study in the Gulf of Valencia. Serra (1986) analysed the natural morphodynamic unit known as "Ovalo Valenciano" (Gulf of Valencia), located in the Westerm Mediterranean Sea, between the Delta Ebro (North), and the San Antonio Cape (South); it is almost a continuous sand beach of approximately 270 kilometers.

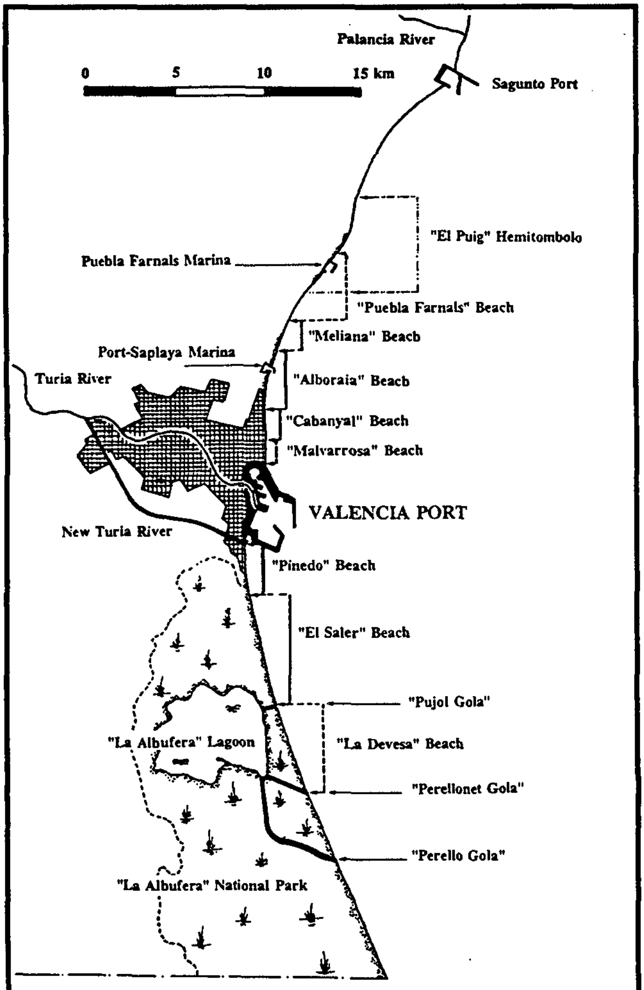


Figure 2. Area of Study

Figure 2 shows the monitorized area located in the “Ovalo Valenciano”, between the “Puebla Famals” marina on the Northem limit and de inlet of the “La Albufera” lagoon, known as “Gola del Perellonet” on the Southem limit, littoral stretch length approximately 30 kilometers. The longshore transport of the coast of Valencia is about 500.000 m^3/yr North to South and 200.000 m^3/yr South to North.

During centuries, there was not enough construction and dredging capacity to build up breakwaters and docks able to resist a sand current of half a million m^3/yr, and a variety of projects enlarging the ancient Port of Valencia failed because of the sand sedimentation processes. Nevertheless, modern construction techniques and the economic development of this century altered the traditional conditions.

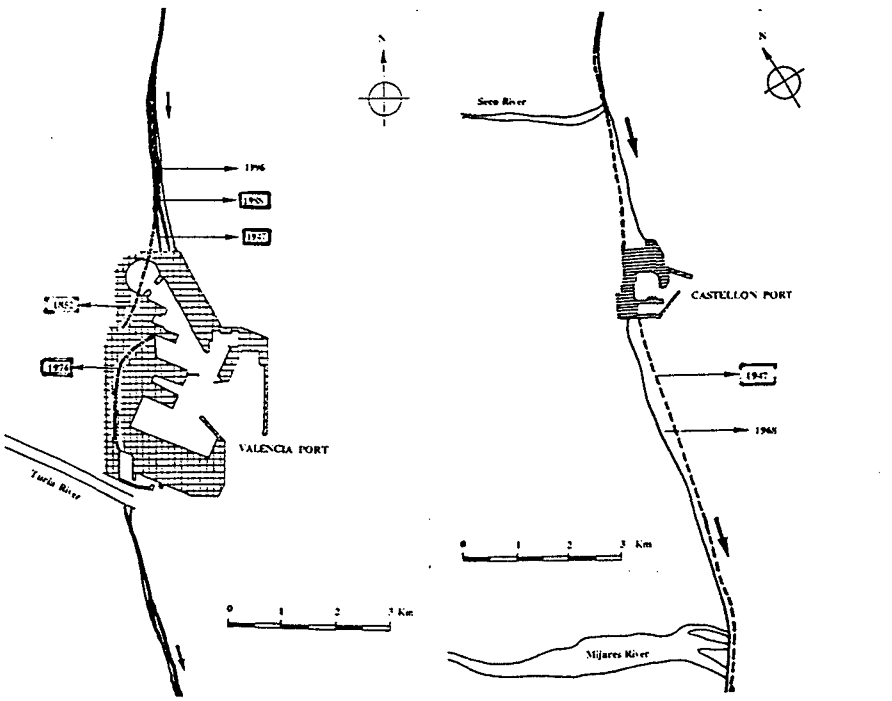


Figure 3. Modification of the Shoreline Around of the Ports of Valencia and Castellón

A barrier to the littoral drift was established on the sandy coast and an erosion process was generated since then on the beaches South of the harbor, were the shoreline is retreating about one meter per year. Not only the Port of Valencia, but also the dams built in the Turia river and marinas North of Valencia are contributing to the beach erosion process.

Unfortunately, neither the Port nor the dams are expected to be removed as barriers in the near future, because they are key elements to the economic development of the region. Additionally, the urban development of the Southern beaches (El Saler) has affected the natural mobility of dunes resulting in a significant retreat of the shoreline during the last three decades.

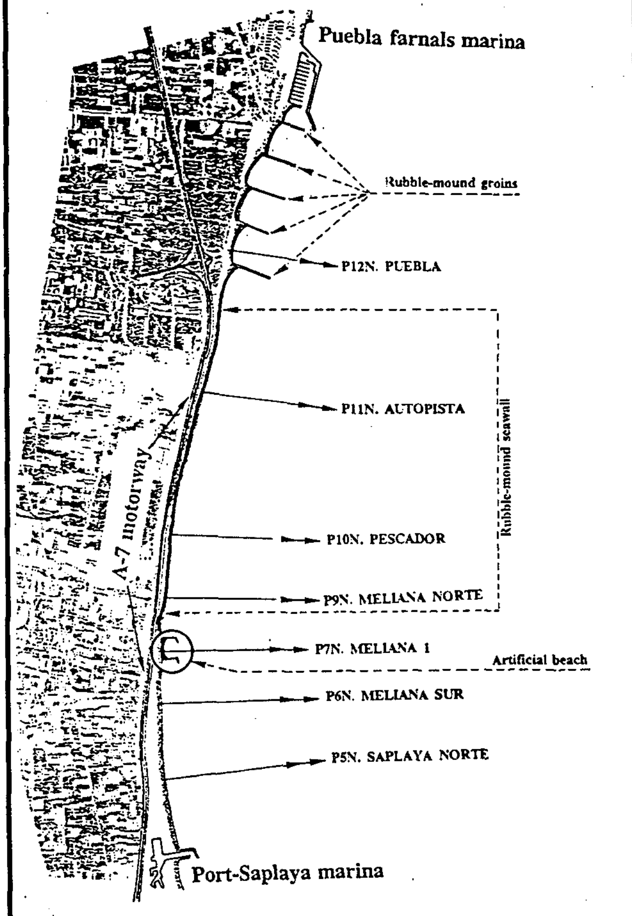


Figure 4. The Coast to the North of the Port of Valencia

The case of the Port of Valencia and the acretion on the Northern beaches and erosion of the Southern beaches is similar to other cases along theGulf of Valencia. The figure 3 shows the modification of the shoreline during this century around of the Ports of Valencia and Castellón.

The coast South of the Valencian Port has two different stretches. The one next to the Port is under erosion and the furthest from the Port is stable. On the other hand, the coast North of The Port of Valencia, presents streches in acretion and others in erosion. The erosion is located South of the barriers of the marinas; the areas in acretion are located North of the marinas, and on the beach North of the breakwater of the Port of Valencia.

The coast to the North, (figure 4), is characterized by the high number of constructions of coastal and nearshore works: the Puebla Farnals and Port-Saplaya marinas, and various coastal work fenders, emphasizing the longgshore revetments which protect the A-7 motorway against direct action from strong waves.

Beach Monitoring Program of Valencia

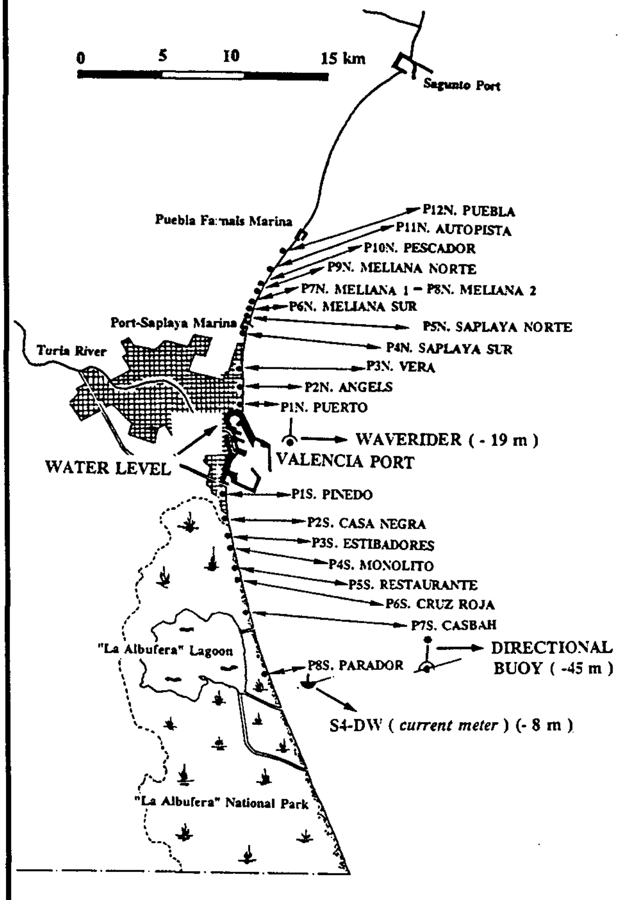
The sand deposits at "El Saler" is in the order of dozens of millions of cubic meters, and short term problems of vital structures caused by erosion is not expected. However, the construction of a new container terminal in the Port of Valencia and the social and economic value of the beaches in the area of Valencia (1.300.000 inhabitants) has favored the establishment of a systematic beach monitoring program. This monitoring will be the basis of the long-term planning and shore protection works on the coast of Valencia.

The Valencia beach monitoring program focuses on two main points: 1) the topographic and batymetric description of the beaches, and 2) the description of wave climate. Figure, shows the location of the wave recording equipment and in the twenty beach profiles that define the beach morphology to the North and to the South of the Valencia Port.

Bathymetric Survey

From the theorical point of view, it is relatively simple to describe the beach erosion process. The aerial topography and batymetry of the beach defines the surface of the sedimentary deposits or rocks along the coast.

The common equipment for systematic bathymetries are echosounders on boats with GPS which are affected by temperature, salinity, and calibration method. The bathymetries on boats must be related to a "zero level" which requires a high precision topographic network and a continuous measurement of the mean water level during the beach survey; it is a difficult to estimate the error level of the survey because the high precision measurement techniques, when available, are low-efficient.



Figue 5. Beach Profiles and Wave Recording Equipment

Figure 6 shows a scheme of the three different surveying techniques commonly used in the beach monitoring programs of Valencia. The first technique is a systematic automated method based on an echosounder boat mounted with GPS. The second technique is a manual method based on an small dinghy and chain; and the third technique is a manual method based a land rod readapted for marine purposes, this technique is known as ***Beach Profiler (BP)***.

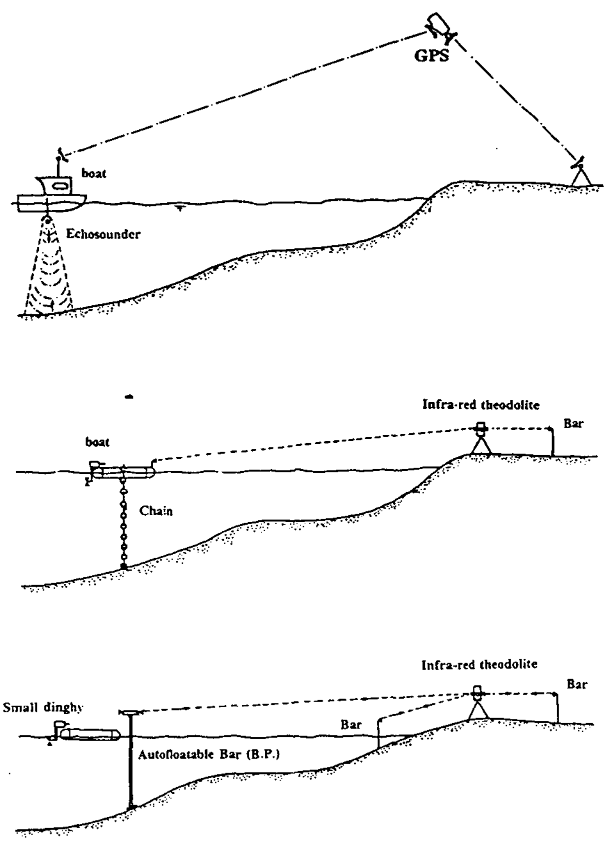


Figure 6. Scheme of Bathymetric Techniques

__The Beach Profiler (BP)__ Within the last decade new measuring systems for bathymetric survey with a common criteria of moving land topography to marine topography have been considered by different research groups. Following this research line the Laboratory of Ports and Coast of Univerisidad Politécnica de Valencia has developed the denominated Beach Profiler (BP) represented in Figure 7. The unit has proved its effectivity as a precise unit for beach profile measuring in beach monitoring. A basic idea is that, in the long-term, cost-efficient beach monitoring techniques appear to be key elements in developing apropiate shore protection and beach nourishment plans.

BP is a high precision and low-cost beach profiler system developed during the frist monitoring program of "El Saler" which is being also applied for monitoring the beaches North of Valencia, and may become a standard low-cost system for regional and decentralized control of beaches along the Spanish Mediterranean coast.

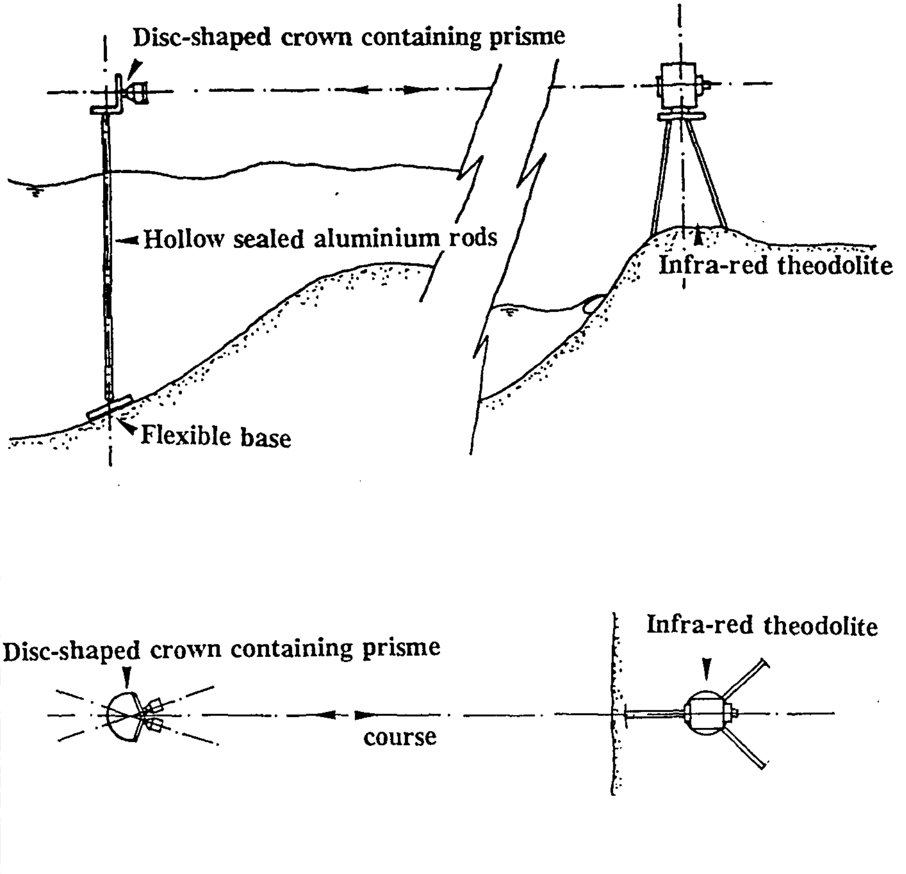


Figure 7. Beach Profiier (BP)

The BP system only requires a two man work team aboard to a small boat, and a land surveyor with a conventional infra-red equipment. The especial designed element to measure the level of the sea botton was a self-floatable aluminium bar, with a crow on the top on which the infra-red reflectors are fixed covering all directions and an articulated led plait in the botton. The BP shows the following characteristics: high precision (error < 2 cm), high efficiency (about 60 points/hour), low cost, and simplicity. Figure 8 shows a typical enveloped and standard deviation of the elevation of the measured profiles using BP.

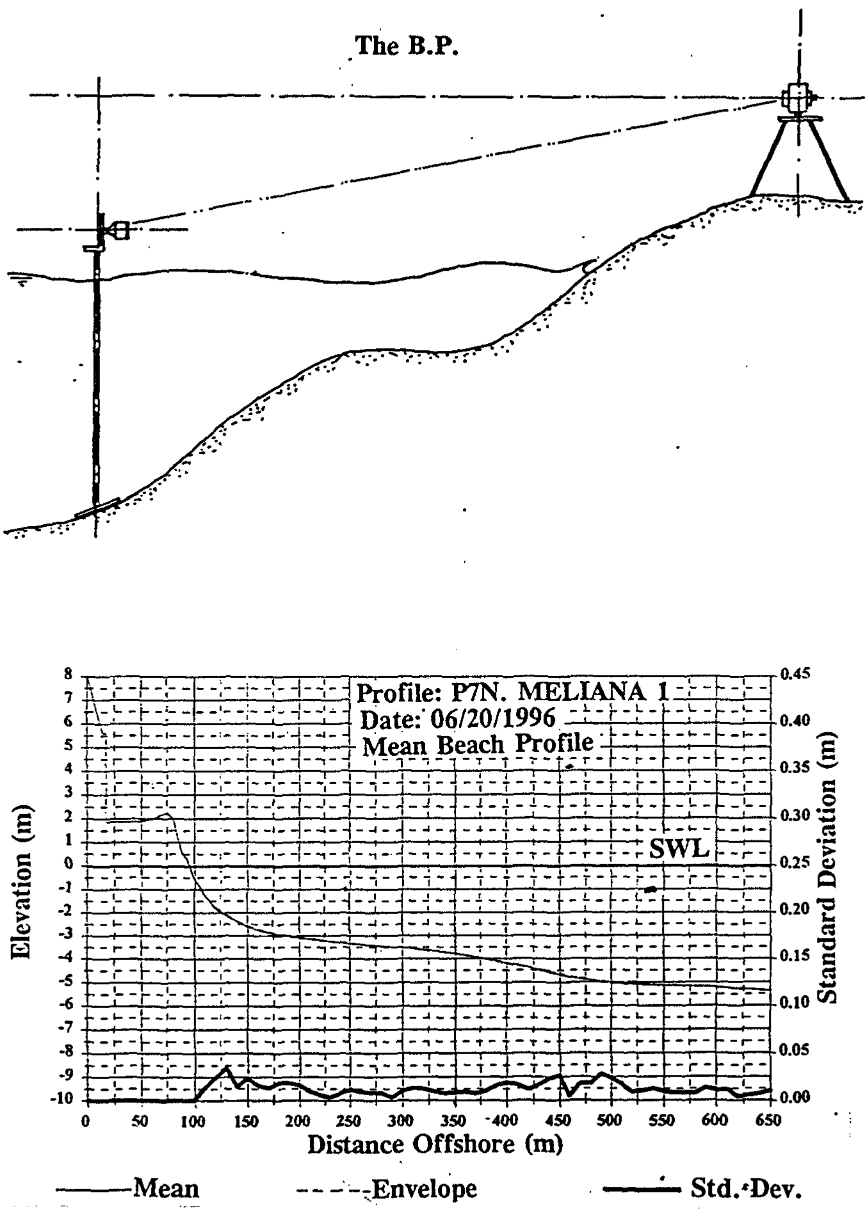


Figure 8. Profile Envelope and Standard Deviation in Elevation (P7N.MELIANA1) Using the BP

Beach Profiles: Errors

Esteban (1993) and Esteban et al. (1995) analysed the problems associated with the use of different bathymetric systems in beach monitoring. Table 1 shows a comparison of different bathymetric tecniques, incorporating the results obtained by the BP.

Bathymetric Tecnique	Sources of Error	Estimated Error	Cost
ECHOSOUNDER	➪ Mean water level: *Tides* *Sstrong surges,...* ➪ Calibration: *Temperature (°C)* *Salinity (g/l).* ➪Boat movement: *Heave, Pitch, Roll.*	≈ 10 cm *(Mediterranean)*	High
CHAIN	➪ Mean water level: *Tides* *Strong surges,...* ➪ Manual operation	≈ 20 cm *(Mediterranean)*	Low
SLED *Stauble et al. (1993)*	➪ Terrestrial topography ➪ Positioning	σ ≈ 7 cm (Atlantic)	High
CRAB *Birkemeier et al. (1993)*	➪ Terrestrial topography ➪ Positioning	σ ≈ 1 cm (Atlantic)	Very High
BEACH PROFILER	➪ Terrestrial topography ➪ Positioning	σ ≈ 2 cm (Mediterranean)	Low

Table 1. Sources of Error Corresponding to Different Bathymetric Techniques

Conclusions

High precision and cost-efficient beach surveying techniques have been developed during the monitoring program of the beaches of Valencia (Spain).

The BP method is simple enough to be applied by a general land surveyor with a minimum training and may be extended to a variety of beaches for systematic and low-cost monitoring programs. The technical characteristics: are:

1.- *High precision (1 cm < error < 2 cm).*

2.- *High effiicency (about 60 points/hour).*

3.- *Maximun length profile: 1000 m.*

4.- *Maximun water depth: 10 m.*

5.- *It does not requires specially trained personal.*

6.- *The BP may be considered a simple terrestrial topography system adapted for monitoring beaches.*

Continuous mean water level measurements during surveys are unnecesary, neither is special equipment nor highly trained personell required.

Therefore, the BP is adequate for manual beach monitoring and the problems of the BP are similar to terrestrial topography.

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