

## CASE STUDY

### *ESPINHO - 100 years of Beach Protection*

**LOCATION:**

*Espinho, Aveiro, Portugal*

**TOPIC:**

*Beach Protection*

**KEYWORDS:**

*Coastal defence, coastal erosion*

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## EXECUTIVE SUMMARY

The municipality of Espinho is in the Aveiro district, located on the north Atlantic coast approximately 16km south from Porto. The municipality has a total area of 21.1 km<sup>2</sup> and a population of about 33 thousand people in its 5 parishes (Espinho, Anta, Guetim, Silvalde and Paramos), about 20 thousand of which are concentrated on the urban seafront of Espinho.

Located in the peripheral area of the city of Porto, which includes the municipalities of the Porto Metropolitan Area together with Póvoa do Varzim, Vila do Conde, Maia, Valongo, Matosinhos, Porto, Gondomar and Vila Nova de Gaia, Espinho has unique characteristics which make it more than just a dorm city. Beyond being an important residential area Espinho is also an important tourist centre, living close to the beach and to the sea. Tourism-related economic activities, such as hotels, restaurants and waterfront bars, Casino activities and other hospitality industry services are growing in relation to the other economic sectors, particularly agriculture and fishing, and assuming a significant share of the local economy.

In addition, Espinho also has a long history (more than 100 years) of damage caused by the sea. In fact, erosion phenomenon in Espinho has been in the news since 1869.

Since the construction of the first sea defences in 1909 (destroyed in 1911), successive generations have watched the Espinho coastline retreating and progressing, landward and seaward by many meters. Nowadays, the city is artificially protected by two large groynes, one in the north extending for 350m and another in the south for 400m, and a 400m seawall. The situation is now considered to be stable thanks to these protections.

This case study report features a comprehensive chronology of erosion events in Espinho, and gives an overview of the past and current issues concerned with it. The information gathered in this case study features in Veloso Gomes *et al.* (2005).



Photo: Aerial view of the beach during the summer season (source: postcard from Espinho).

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## 1. INTRODUCTION

The history of Espinho beach dates to the first decades of the 19<sup>th</sup> century when a small population of fishermen from Furadouro settled their activities on this beach. From 1830 on, many bourgeoisie families from neighbouring areas began to choose this beach for their summer holidays and this gave origin to significant changes in the landscape with the construction of fine cottages and houses. With the development of transport networks, especially the railway, in the second half of the 19<sup>th</sup> century, the village grew significantly and reached a status of being an important seaside resort at a national level. Furthermore, the new means of transportation was also an important factor for the industrial development of the village, contributing to population settlement and the growth of the services sector. Due to this development – sustained by the tourism associated with the beach – Espinho obtained its administrative autonomy at the end of the 19<sup>th</sup> century with the creation of Espinho Municipality, which at that time only incorporated Espinho.

Nowadays, the city includes 5 parishes (Espinho, Anta, Guetim, Silvalde and Paramos) within a total area of 21.1 km<sup>2</sup> and a population of about 33 thousand people, of which about 20 thousand are concentrated on the urban seafront of Espinho.



Figure 1. Espinho location.

## 2. COASTAL EROSION FRAME IN ESPINHO AND ITS CONSEQUENCES

### 2.1. Introduction

Espinho has a long history (more than 100 years) of damage caused by the sea. In fact, erosion phenomenon in Espinho has been in the news since 1869.



Since the construction of the first sea defences in 1909 (destroyed in 1911), successive generations have watched the Espinho coastline retreating and progressing, landward and seaward by many meters. For instance, between 1885 and 1910 the shoreline retreated 225m – this corresponds to the amazing erosion rate of 9m/year, and the old village centre was almost completely swallowed by the sea (Figure 2).

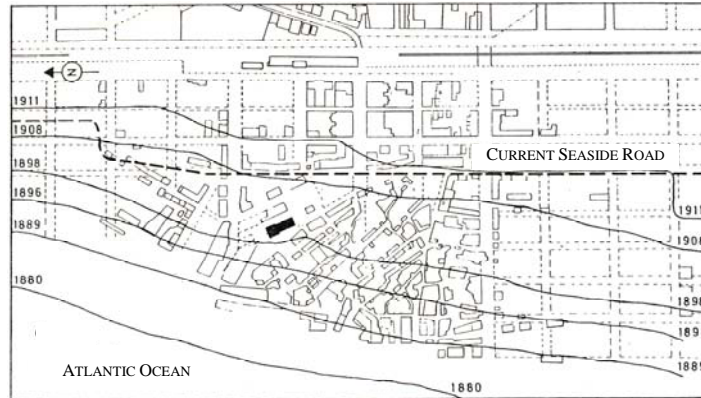


Figure 2. Coastal retreat in Espinho between 1880 e 1911 (Mota Oliveira & Martins, 1991).

This coastal stretch is mainly a sandy coast with no natural rock protection and is therefore very vulnerable to erosion in conditions of poor sediment availability. Nowadays, the city is artificially protected by two large groynes, one in the north extending for 350m and another in the south for 400 m, and a 400 m seawall. The situation is now considered to be stable thanks to these protections. Figures 3 and 4 show the evolution of the urban seafront of Espinho and of the protection structures between 1958 and 1988.

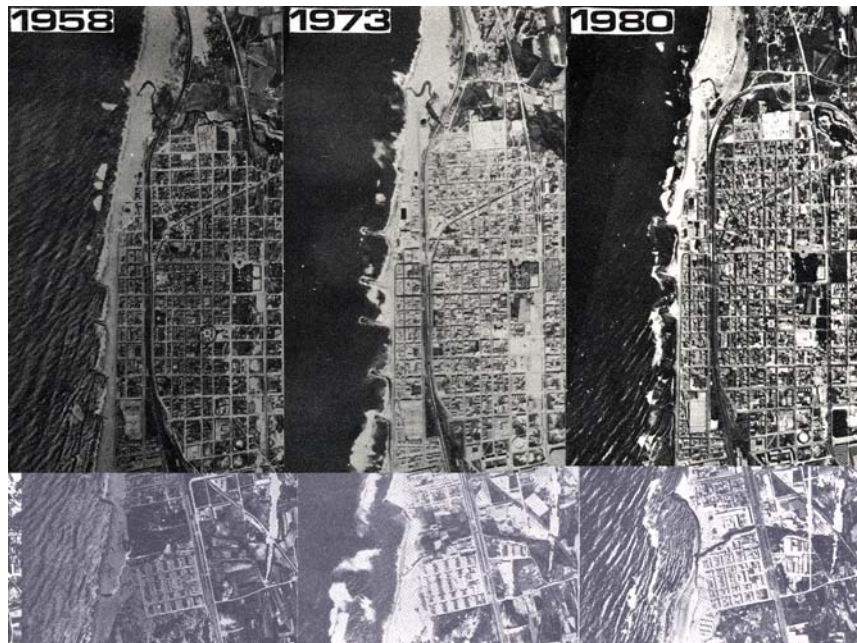


Figure 3. Coastal evolution before the construction of sea defences (Mota Oliveira & Martins, 1991).

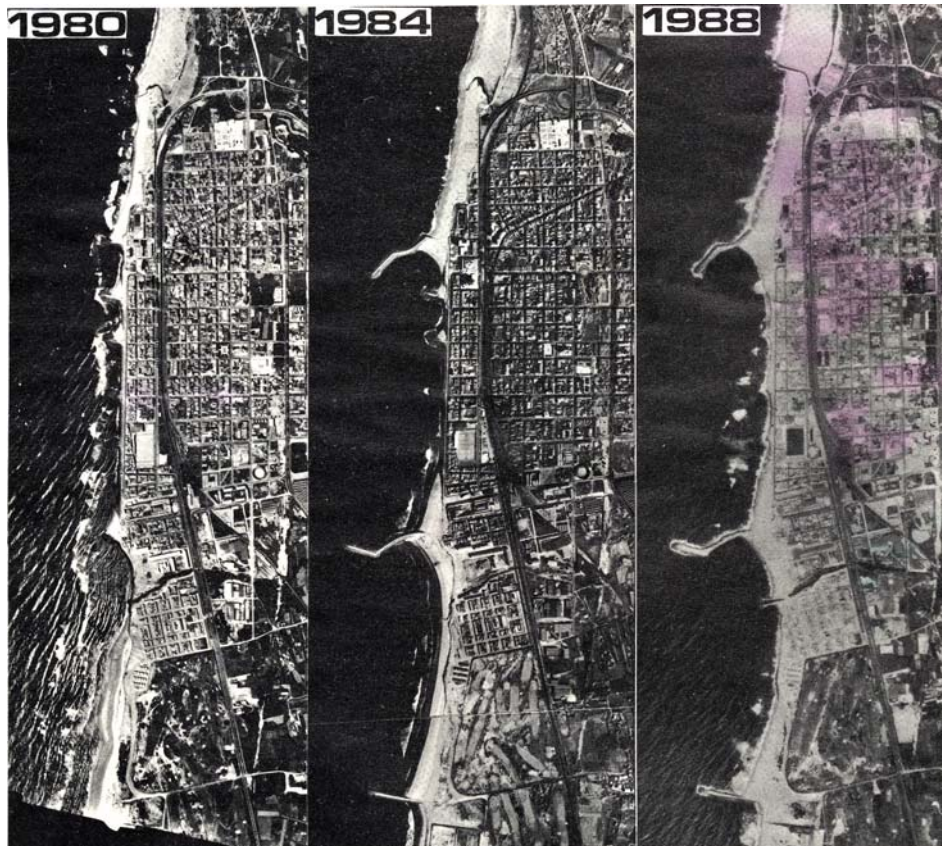


Figure 4. Effect of the coastal defences on the shoreline (Mota Oliveira & Martins, 1991).

## 2.1. Chronology of Erosion Events

The evolution history of this coastal town can be made through a chronology of several erosion events.

### 1869 – 1874

The first news about damage by sea actions in Espinho beach was in 1869. Over the next 5 years there were so many flooding events that the population had to retreat landward by about 95 m.

### 1889

Violent damage and the first reported destruction of some fishermen's cottages on the beach.

### 1890

On the 22<sup>nd</sup> February two houses and the hot bathing facilities were destroyed by violent sea actions.

### 1891

The seawater progressed landwards by about 30m in relation to pervious sea flooding. Ten cottages and twelve old buildings were destroyed.

#### 1895

Some houses in the Queen's quarter, built by the Portuguese Queen D. Maria Pia in 1891, were destroyed. Despite the acknowledged dangers, some of the houses were rebuilt.

#### 1896

This was a year when major destruction events occurred. Twenty-five cottages, two new buildings and twelve old buildings were destroyed.

The Galegos Chapel was intentionally burned because it was no longer safe. This indicated for the first time, that it is recognized that perhaps the defence of some heritage sites is not possible.

Another violent sea event destroyed many houses in an area 300m in length by 50m in width.

#### 1898

The events of this year were similar to those in 1896. The area destroyed was about 40m in width and 300m in length.

#### 1904

In December, the Holy Mary of Help Chapel was destroyed.

#### 1905

The fishermen were those most affected by severe sea events. About 70 families were affected by the destruction of cottages.

#### 1906

The new Holy Mary of Help Chapel was built.

#### 1908

This was a very important year because it was when a media-led campaign began to pressure the political system to take measures to protect the population from erosion and ocean storms.

A commission was nominated that proposed the construction of a longitudinal protection along the residential area, with a total length of 1253 m.

#### 1909

A large seawall, partially founded on piles, was constructed, 354m in length and 3.5m high.

#### 1910

The sea destroyed the Chapel built in 1906. In February a storm caused slight damage on the seawall. In December a very severe storm caused the destruction of 40m of the wall and 60m of the back wall.



Figure 5. Holy Mary of Help Chapel destruction.



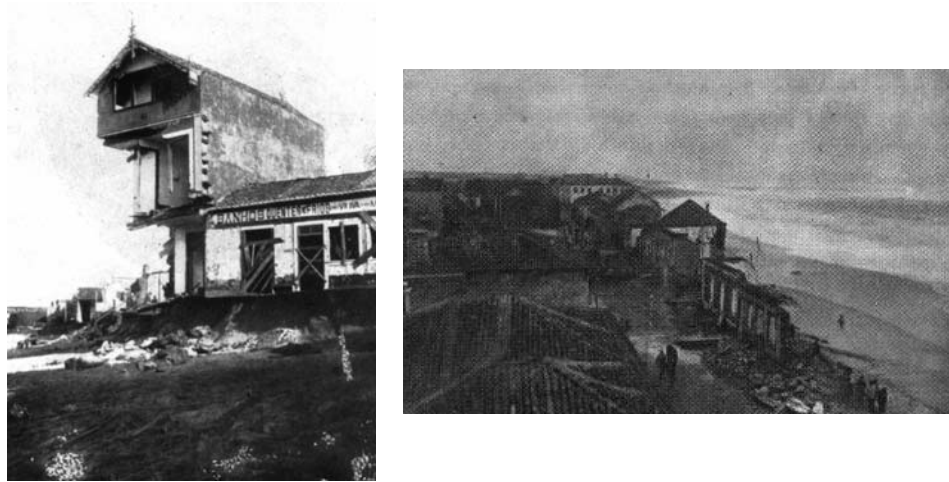


Figure 6. Houses destroyed.



Figure 7. Wall destruction.

### 1911

After the destruction of the wall, reconstruction works were promptly started. At the end of January the reconstruction works were stopped after almost complete destruction by a new severe storm. In the meantime, as an experiment, two wooden groyne were built and the beach grew slightly.

Engineer Von Hafe decided that the defence of Espinho was only possible through the reconstruction of the foredune. To attain this goal he started building a groyne field, which included some groyne in stone (main groyne) and others in wood (secondary groyne).

### 1912

Additional destruction led to the immediate building of two groyne, whose effect on the beach growth was already acknowledged. However, these works were not conclusive, as the groyne should have been 50m longer.

In December another severe wave attack/erosion on the beach caused the destruction of about 200 buildings.





Figure 8. Experimental wood groyne.



Figure 9. Groyne construction.

### 1915

Due to new storms, the sea had reached the street immediately south of the first unfinished groyne.

### 1928

The demolition force of the sea had reduced in preceding years, leading to beach recovery and to an optimistic outlook for shoreline evolution. This fact caused the coastal defence works to be neglected.

The firemen opened the life-saving section (shelter house).

### 1931

The erosion phenomenon restarted, contrary to the accretion trends seen in the previous years.

### 1932

The coastal defence works suffered from the lack of financing and in the meantime, the foundations of the north groyne became exposed.

### 1934 – 1935

The reconstruction/construction of the defence groynes was decreed, which meanwhile had been practically destroyed. This reconstruction was done on concrete blocks, taking advantage of existing rocks as foundations. The north groyne was 150m in length, and had 8.25m crest height on the root and 4.17m on the head. The south groyne was also 150m in length, with crest heights of 8.85 m on the root and 2.87 on the head. Updrift of the south groyne the construction of a third groyne was started, but never finished. Downdrift of the north groyne two other groynes were built, one of which was partially destroyed almost immediately upon construction because its foundations did not reach bedrock.

In November, a wood piling structure was constructed in front of 23<sup>rd</sup> street.

### 1936

The life-saving shelter, built in 1928, was destroyed.



Figure 10. Life-saving shelter.

#### 1939

A small breakwater of concrete blocks was constructed, 44m in length, immediately downdrift of the north groyne, near the low tide level.

#### 1940

The idea of constructing a sheltered harbour for fishermen was raised. However, this could not be a priority before the beach defence work was finished, and the fishermen's aspiration was never realised.

#### 1943

Several houses and the swimming pool were again destroyed, after having already been reconstructed. Construction of a new 90m groyne updrift the south groyne was initiated.

#### 1944

This year was marked by destruction of the Queen's Quarter of 1891, after the repeated reconstruction of several houses. Sea intrusion progressed through 33<sup>rd</sup> street, and at the end of the year an extension of the existing groyne was made using 240 6-ton concrete blocks.

In November a project for the emergency works on Espinho littoral was drawn up.

#### 1946

Emergency works between the central groyne were approved. In November the unprotected stretch between 27<sup>th</sup> and 33<sup>rd</sup> street is again hit.

#### 1947

In February, the wooden wall between 27<sup>th</sup> and 31<sup>st</sup> was completed. The north side of the swimming pool was destroyed and its foundations were laid open.

Using rocks, the defence of this area of the beach was started in the summer and finished at the end of the year. The accretion that occurred as a result allowed a more optimistic outlook for this struggle against the sea.

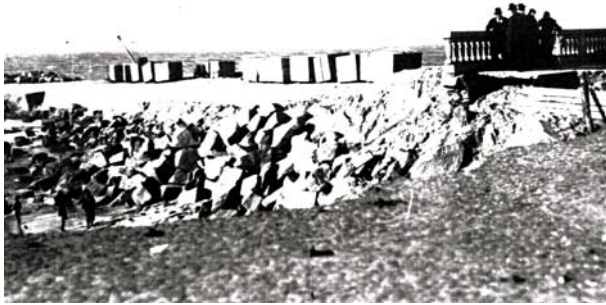


Figure 11. Groyne and esplanade.



Figure 12. Concrete blocks construction.



Figure 13. The sea reaches the swimming pool.

1948

The beginning of the year marked the start of works on the south part of beach. This project to promote beach accretion consisted of constructing 11 groynes and a wooden protection barrier from 33<sup>rd</sup> street to the fishermen's quarter. To avoid more damage between 23<sup>rd</sup> and 25<sup>th</sup> streets, the 9<sup>th</sup> street groyne was finished and a new one on 27<sup>th</sup> St. constructed. The central groynes suffered severe damage on their heads that were not repaired. The esplanade is practically all dismantled.

The final defence plan was approved and work began with the construction of a 4m-wide seawall on rock foundations updrift the 27<sup>th</sup> St. groyne. This work replaced the wooden retaining wall.



Figure 14. Wood protection.

## 1949

The south part of the wall was concluded and the waves did not cause problems. However, the north section was severely battered. The esplanade was opened to the public in the summer and during the winter it was almost destroyed. The spring tides caused the destruction of almost all the wood groynes, and the ones located on 27<sup>th</sup> and 33<sup>rd</sup> streets proved to be insufficient and had to be replaced by a more solid groyne.



Figure 15. 2<sup>nd</sup> street destruction.

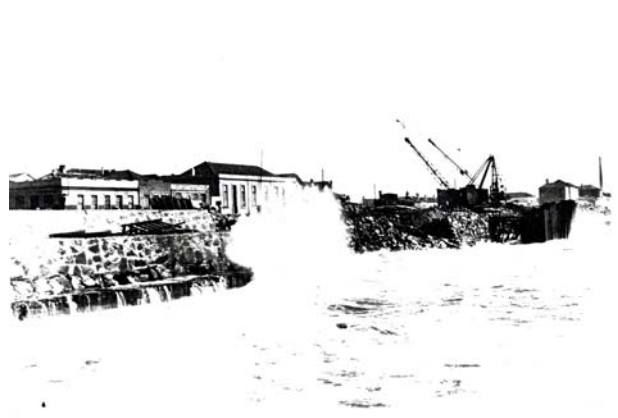


Figure 16. 2<sup>nd</sup> street in 1949.

## 1950

June marked the beginning of work to complete the seawall from the northern limit of the swimming pool till the 27<sup>th</sup> street groyne.

## 1951

The work on the longitudinal defence continued between 27<sup>th</sup> and 33<sup>rd</sup> streets. Sea attacks on the south zone caused significant damage on 2<sup>nd</sup> street. As an emergency measure, concrete blocks were dumped into the sea to hold back the full force of the waves. Due to the lack of financing, the work was stopped before their conclusion and therefore the south part remained very exposed to the sea.

## 1952

The works between the 27<sup>th</sup> and 33<sup>rd</sup> streets took two years to complete due to successive sea attacks. To extend it a few more meters a number of large boulders were dumped into the water.

## 1959

The coastal defence works were stopped for a period of time.

A 1330m extension of longitudinal defence is approved, from the swimming pool till the Brandão Gomes industrial site.

## 1960

The north part near the swimming pool was hit several times.



1969

In June the south groyne was extended.

1970

In November the north groyne near the swimming pool was extended.

1973

The swimming pool wall was again destroyed, along with almost the entire north side esplanade.

1974

The sea-wave fury caused the collapse of about 20m of the 2<sup>nd</sup> street promenade. The water threatened the fishing quarter over a 10 m length.

1979

The Espinho littoral was again subjected to violent sea attacks. On 2<sup>nd</sup> street the pavement was ruined by wave energy and the north part of 8<sup>th</sup> Avenue was partly destroyed.



Figure 17. North groyne in 1970.



Figure 18. 1979 Storms.



1981 – 1983

Construction of four larger groynes with tetrapod heads.

1987 – 1989

Demolition of three of the old groynes.

1994

Significant damage on the head of the north groyne.

1997

Reconstruction of all existing groynes led to increased beach growth.

*All photos in “Defesa Costeira em Espinho – História e Situação Existente”, which authors are José Manuel Tavares, Fernando Barbosa and Adelino Júlio.*

### 2.3. Current Situation

Nowadays, the city of Espinho is artificially protected by two large groynes, one in the north extending for 350m and another in the south for 400 m, and a 400 m seawall. The situation is now considered to be stable thanks to these protections.

These defences are able to holding back the sea and to enlarging the beach dimensions, despite the fact that the growth trend observed after groyne reconstruction in 1997 has slowed down in recent years and the beach is showing some signs of erosion, especially on the central area between the north and south groynes.

### 3. OUTLOOK

As previously mentioned, Espinho has one of the oldest histories of problems related to coastal erosion in Portugal. Indeed, the first reports go back to the XIX century, to 1869 when the population was forced to retreat several meters inland due to successive flooding events. These events would persist during the following century, menacing the urban nucleus that in the meantime had grown significantly and become one of the most important tourism centres of the north Region, apart from also being an important residential area of greater metropolitan Porto.



Figure 19. Urban seafront of Espinho (INAG<sup>1</sup> aerial photographs 2001).

<sup>1</sup> INAG – Institute of Water (Ministry of Environment), prime legal authority in the Portuguese coastal zones.

The successive generations of Espinho have lived under the threat of sea attacks and have developed some feeling for coastal erosion. Nevertheless, there is always some dispute about the way of solving the problem. The population and local authorities are, in general, of the opinion that coastal defence works are necessary and they usually demand the construction of such works when threatened by erosion phenomena. The scientific community is often opposed to such construction, especially in the case of groynes and seawalls, which in some situations accelerate other local coastal erosion events.

Irrespective of pros and cons, the so-called hard coastal defences are indispensable. Indeed, there are few alternatives to protect this stretch from eroding in view of the coastal type – a low sandy coast with little natural protection and a severe wave climate, but especially to protect the urban seafront which is still in an area of high-risk vulnerability to sea attacks and flooding, even with these defences.

## REFERENCES

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