

Current Measures to Protect the Romanian Coastline of the Black Sea

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BACKGROUND

The length of the Romanian coastline is about 244 kilometers (representing 6% of the total length of Black Sea shore) and it is divided into two main sectors:

- **Northern unit** (part of the Danube Delta Biosphere Reserve), stretching on 170 km, from the Ukrainian border to Midia Cape and consists of shore with deltas, lagoons and sandy barriers, often less than 2 m altitudinal;
- **Southern unit** (Cape Midia - Vama Veche, at the Bulgarian border), with a length of about 74 km, it is a relative high shore, with cliffs, mostly active, with high between 3 - 35 m, and small beaches in front of lagoons and cliffs.

The Romanian coastline as well as other coastal areas was heights affected by erosion. Thus, annual evaluations made by NIMRD in the period 1980 - 2007 determined frequently a 60-80% shoreline retreat.

Recently, in the period 2005 - 2013 years were elaborated scientific and technical documentations for the development of the Master Plan of the Romanian Black Sea coast to mitigate coastal erosion in order to increase the value of the coastal zone and create new areas of beach tourism, through two major projects:

- between 2005-2007 the "Study on the Protection and Rehabilitation of the Southern Romanian Black Sea Shore" (JICA, 2007- coordinator *Yoshimi GODA*, Professor Emeritus);
- between 2010 - 2013 the "Protection and rehabilitation coastal zone" (Halcrow, 2012).

In these projects was drawn up a Strategic Plan for Coastal Protection, which will run for more than 30 years, with coastal protection measures planned in the short, medium and long term. These works include measures to reduce wave energy by building new dams, beach fill (nourishment) with dikes of stability sand (spurs) and measures for retaining the sand on the beach by building new dams, repair the old detached breakwater and existing groins.

OBJECTIVES

The main objectives of the presentation refer to:

- Summary of coastal protection works planned in the short term and implemented at the end of 2015 year, in the southern Romanian shore;
- Evaluation of the beach geomorphological changes before and immediately after the implementation of coastal protection measures.

MATERIALS & METHODS

An important component of the Strategic Plan for Coastal Protection is the local monitoring to collect updated information on the performance of coastal works, which are essential for the maintenance and optimization required over the life of these projects (about 50 years) and substantiation studies and projects for these works.

In this way NIMRD, which conducted annual evaluations of geomorphological changes for backshore from the Northern Unit (42 sections) and biannual for the Southern Unit (34 sections) in the period 1980 ÷ 2007, designed 27 landmarks in 2014 for monitoring the geomorphological beach area with the short - term protection measures (MM 1 ÷ MM 5, Ct 1 ÷ Ct 15, Ef 17 ÷ Ef 22). Thus, measurements were made with the level SOKKIA, in November 2014 and 2015, to determine beach changes.

RESULTS

Coastal protection measures planned on the short term in the southern Romanian shore

According with the coastal protection plan, short - term measures were planned for five priority projects in the southern Romanian coast, in order to reduce the risk of coastal erosion and rehabilitate the area for 7.1 kilometers of shore in the locations, Mamaia South, Constanta (Tomis Nord, Tomis Center, Tomis Sud) and Eforie Nord. The beach area expected to be created is about 33.7 ha. These measures were put into operation at the end of 2015.

Mamaia Sud Location

The District of protected shoreline with length of 1.2 km is the southern part of the tourist resort Mamaia (about 7 km long). The following were works implemented here: rehabilitation of two large structures, nearshore detached breakwater, each of 250 m in length, groine connected to the shore for retaining sand with the length of 200 m, structure liaison between dams with a total length of 341 m, spurs with length of 85 m (consisting of 6 with total length of 510 m), buried in beach fill, as a conservation measure, retaining sand beach and increase stability and nourishment beach on a length of 1.2 km. Before nourishment the average width of the backshore in this location was 66.9 m and after sanding it increased to 153.2 m, representing a recovery of 76.4 m.

Changing the width (m) of the beach before and after nourishment

Landmark	Before nourish.	After nourish.	Nourish.
MM 4	89.9	155.7	65.8
MM 3	59.8	133.8	74.0
MM 2	71.9	171.4	99.5
MM 1	46.3	151.7	105.4
Average	66.9	153.2	86.4

The beach in front of the landmark MM1 with narrowest width was tripled in the size of the intake of sand.

Constanta Area

Protection works in the area of Constanta city were divided into 3 sections: Tomis Nord (1.5 km), Tomis Centru (0.9 km) and Tomis Sud (1.5 km).

Tomis Nord Location

This location provided hydro coastal protection structures consisting of: extension with 400 m of Marina Pescarie breakwater (300 m) in the northern part, two breakwaters of 270 and 290 m in the central and southern part, submerged breakwater on length of 260 m, beach nourishment on length of 1.05 km.

Before beach-fill the average width of the backshore in this location was 24.5 m and after sanding it increased to 142.2 m, represented a recovery of 117.7 m.

Changing the width (m) of the beach before and after nourishment

Landmark	Before nourish.	After nourish.	Nourish.
CT 15	70.0	149.3	79.3
CT 14	7.0	139.6	132.6
CT 13	7.0	125.8	118.8
CT 12	7.0	144.2	137.2
CT 11	31.7	152.2	120.6
Average	24.5	142.2	117.7

The shore in the front sectors CT13, CT 14 and CT 15 profiles was very narrow and present a defense of stones. After sanding, the beach increased by more than 100 m.

Tomis Centru Location

In this location were put in to work: two breakwaters including one located in the north with a length of 350 m and another in the southern part of 340 m, a submerged breakwater with length of 245m, beach nourishment on a length of 0.85 km.

Before nourishment it the average width of the backshore in this location was 36.6 m and after sanding it increased to 141.6 m representing a recovery of 105 m.

Changing the width (m) of the beach before and after nourishment

Landmark	Before nourish.	After nourish.	Nourish.
CT 10	32.2	147.0	114.8
CT 9	33.2	136.3	102.2
CT 8	25.9	131.2	105.3
CT 7	55.2	153.0	97.9
Average	36.6	141.6	105.0

Tomis Sud Location

In this location were put in to work: groin of 350 m long, extension of breakwater with 100m, two submerged breakwaters of 245 and 260 m, beach nourishment on a length of 1.47 km.

Before nourishment the average width of the backshore in this location was 51.4 m and after sanding it increased to 159.8 m, representing a recovery of 108.5 m.

Changing the width (m) of the beach before and after nourishment

Landmark	Before nourish.	After nourish.	Nourish.
CT 6	33.7	147.6	113.9
CT 5	31.9	164.4	132.6
CT 4	42.8	137.5	94.7
CT 3	33.6	129.5	95.9
CT 2	38.2	170.4	132.2
CT 1	128.0	209.5	81.6
Average	51.4	159.8	108.5

Eforie Nord Location

The beach had a length of approx. 1.2 km and is located north of the Belona Marina.

In this location were put in to work: three groins in length of 135, 180 and 174m, three submerged breakwaters in length of 200, 200 and 275 m, beach nourishment on 1.2 km length.

Before nourishment the average width of the backshore in this location was 26 m and after sanding it increased to 148.4 m representing a recovery of 122.4 m.

Changing the width (m) of the beach before and after nourishment

Landmark	Before nourish.	After nourish.	Nourish.
Ef 22	7.0	114.6	107.6
Ef 21	7.0	149.7	142.7
Ef 20	7.0	144.1	137.1
Ef 19	42.6	175.2	132.6
Ef 18	34.4	147.5	113.1
Ef 17	58.1	159.5	101.4
Average	26.0	148.4	122.4

The shore in front of sectors Ef 20, Ef 21 and Ef 22 transects was very narrow and presented a defense of stones. After sanding, the beach increased on average by 136 m. In this location the largest beach restoration was determined.

SUMMARY

Recently, in Romania was drawn up a Strategic Plan for Coastal Protection, which will run for more than 30 years, with coastal protection measures planned on the short, medium and long term. In the southern coast, in order to reduce the risk of coastal erosion and rehabilitate the area for 7.1 kilometers of shore the location, Mamaia Sud, Constanta (Tomis Nord, Tomis Centru, Tomis Sud) and Eforie Nord. This measures was put into operation at the end of 2015 year.

CONCLUSIONS

In the framework of coastal protection measures planned on the short term from the five locations (Mamaia Sud, Tomis Nord, Tomis Centru, Tomis Sud and Eforie Nord) were made nine dams transverse of shore (groins), seven dams longitudinal of shore (nearshore breakwaters) and beach-fill sanding on about 6 km.

Based on geomorphological measurements (25 sections) performed by NIMRD before and after beach nourishment, it result that the width of the backshore increased as follows:

- 86.4 m in the Mamaia Sud;
- 117.7 m in Tomis Nord;
- 105 m in the Tomis Centru;
- 108,5 in the Tomis Sud and;
- 122.4 m in the Eforie Nord.



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