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Dobrogea at 140 Years after its Union with the Romanian State

An Example of Contemporary West-Pontic Multiethnic Understanding

EX PONTO

The Port of Sulina, Eeastern European Seagate - Past and Present

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Introduction

The reception basin of the Black Sea covers about 1,864,000 km^2, most of which are the river basins of the north-western rivers: Danube (43.8%), Dniester, Bug, Dnieper, and Kuban. Their combined flow means approximately 276 km^3/year, of which only the Danube returns about 70%. Regarding sedimentary intake, the total amount of sediment transported and discharged to the continental shelf by these tributaries is approximately 61 x 10^6 tons, of which the Danube means about 81% (Wong *et al.*, 1994).

The current sedimentary processes on the continental shelf of the north-western Black Sea are marked by the influence of the sedimentary intakes of the rivers that emerge in this area: Danube, Dniestre and Dniepr. Of these, the influence of the Danube is the most important in sedimentation of the seabed of the northern Black Sea area (Panin and Jipa, 2002).

The multiannual average flow (6,550 m^3/sec) measured at the Danube Delta entrance (at Tulcea hydrometric station) is the result of the hydrological balance of the receiving basin (Almazov *et al.*, 1963).

Regarding sediment transport, anthropogenic arrangements of the upper and middle basin of the river has reduced the sediment flow downstream. Starting with 1970, the construction of the two hydropower dams (in 1972 and 1984) and the hydro-technical installations on the Danube tributaries in the Romanian sector (Jiu, Olt, Vedea, Siret) influenced liquid and solid flow downstream.

These structures have led to a considerable reduction of the sedimentary flow at the Danube mouths. For a period of 130 years (Bondar *et al.*,1991) it was estimated that the average sedimentary flow rate of the Danube at the mouths was 51.7 x 10^6 tons/year with a progressive downward trend over time. More recent studies (Bondar *et al.,* 1991) estimate that the sedimentation rate decreased from 67.5 x 10^6 tonnes/year to 25-30 x 10^6 tonnes /year.

For the Sulina branch, the hydrological measurements (February 2007), in the medium-high water period, showed a flow rate of 1,331 m^3/sec (Driga, 2004).

The solid discharge of the Danube was significantly influenced by the construction of hydrotechnical facilities, registering minimum amounts of 337 kg/s after the 1950s, as opposed to the maximum value of 4,428 kg/s reached in 1870. A number of 207 dams exist on the Danube and its tributaries after 1940 (Rădoane and Rădoane, 2005).

A short history of Sulina Channel

Until 1857, the current Sulina channel was in its natural state. The old branch had a sinuous aspect, 83 km long, with widths varying between 120 and 250 m and with depths of the talveg between 2.5 and 9 m below the local water level (Bondar and Papadopol, 1972; Bondar and Panin, 2000).

In volume 5 of the *Great Geographical Dictionary of Romania* (1901), George Lahovari mentioned: "*50 years ago, Sulina was nothing more than a bunch of fishermen's huts, which besides fishing also dealt with the looting of ships that were thrown by the storm in these places.*"

The Crimean Wars (1853 and 1856) between Russia, on the one hand and the United Kingdom, France and the Ottoman Empire, on the other hand, had included the Sulina branch in a new European geographical, political and economic context. The establishment of a *European Commission of the Danube* (ECD) in 1856 and 1906 guaranteed the freedom of navigation and trade on the Danube river. This is, from a historical perspective, an excellent example of European cooperation.

In this context, the evolution of Sulina in the second half of the 19th century and the first half of the 20th century represents a historical model for capitalizing on economic and social potentials found in the

European countries and not only. The location of Sulina at the confluence of commercial shipping routes gave legitimacy to call this town *Europolis*.

Restructuring the markets and redirecting significant international trade flows after the First World War will cause a substantial reduction in naval and maritime traffic in the area, and the port city of Sulina got a marginal position. With this fact, the Danube also loses its historical importance for Europe as a communication route.

The 1930s found Romania in the sphere of Germany's strategic interests and with it its separation from the European democratic states.

It is worth mentioning that agriculture in England was almost inexistent because the tremendous industrial revolution had begun here and most of the population had moved to cities. In 1845, a great famine broke out in Great Britain, so alternatives have been sought for the import of grain to feed its population (Ardeleanu, 2008].

On March 30, 1856, the Conference in Paris decided to set up a Commission under the auspices of the great powers of that time: France, Austria, Great Britain, Prussia and Turkey to carry out works to remove obstacles from the mouth of the Danube and to restore good navigation conditions.

At the time, John Stokes (Fig. 1) delegated from England to the EDC reported a rather worrying situation in Sulina, where residents had a half- piracy life. Immediately, after being elected a member of the EDC, he visited the Sulina and St. George channels to make a more accurate report on the situation at the mouth of the Danube.

This watercourse along with the abnormal width of the branch would have caused a current that led to deposit large amounts of alluvium, that would have formed the Argagni grind (Partizani and Ilgani de Sus). He also found that this part of the branch, due to its narrowing, was very difficult to navigate and many ships were failed in this area. Stokes reports to the Commission that the works to be carried out here are very difficult and require major hydrotechnical engineering.

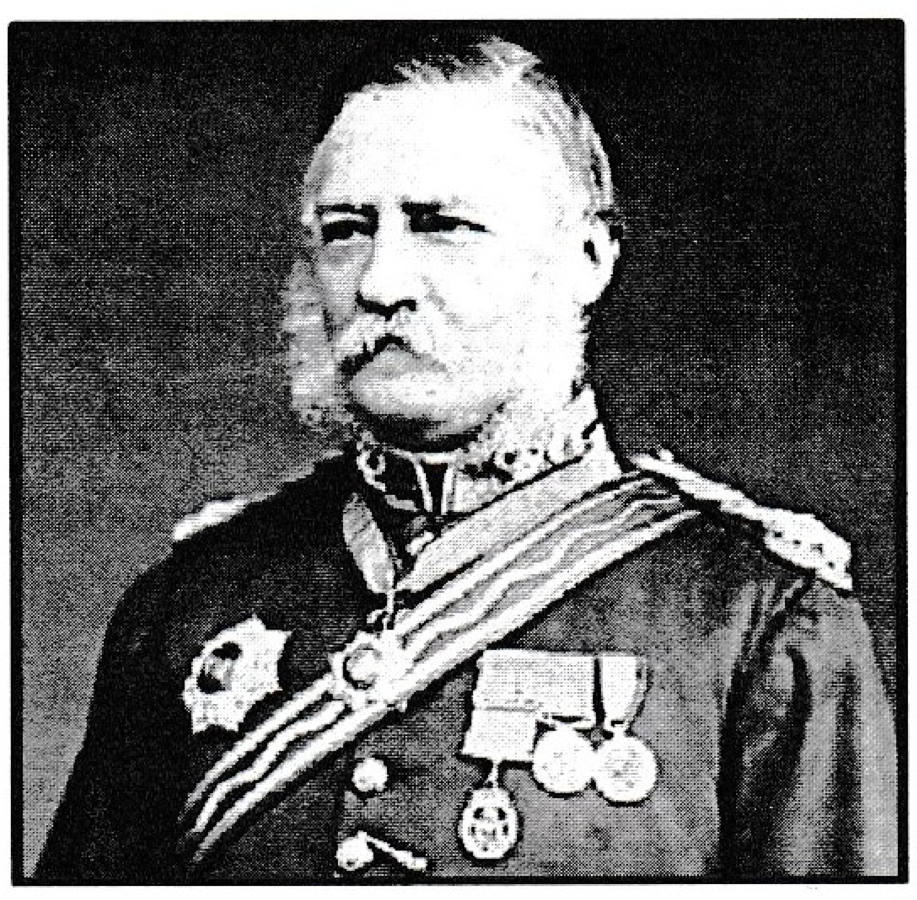

Fig. 1 John Stokes
Source: www.historia.ro

Immediately, after inspecting the Danube's branch, he asked the Commission to provide an engineer in the person of Charles A. Hartley (Fig. 2). In 1865, he was commissioned by the ECD to develop a navigation and police regulation on the Danube, as well as navigation tariffs. According to his autobiography after many years spent here, "it was very painful for him to say goodbye to the Danube."

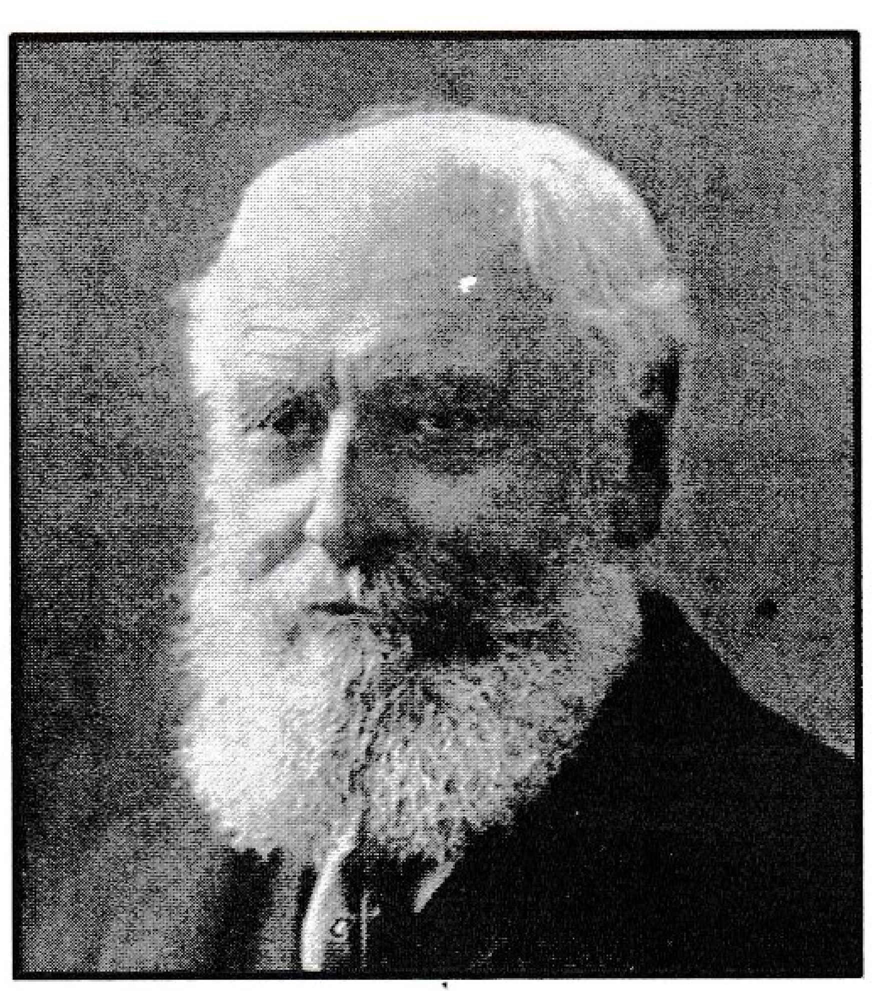

Fig. 2 Charles A. Hartley
Source: www.historia.ro

Sir Charles Augustus Hartley, also called the "father of the Danube," the chief engineer of the European Commission of the Danube at that time designed and carried out much of the work to regulate the Sulina channel and render the navigability of Danube at the Sulina bar (Stănculescu, 2009). The importance of his works was best seen after the completion of the canal and the impact of the Danube transport on many European countries. The complexity of the works carried out at that time and the technical engineering solutions used have not been matched even today to any work done on the Danube river.

After the cessation of the Turkish monopoly on the export of grain from the Romanian Kingdom, cereal exports from the Galaţi and Brăila harbours increased from 50,000 tonnes in 1837 to 210,000 tonnes in 1845. On this occasion, English merchants took over trade in this area but faced a significant problem because their large capacity vessels had a draft. This has led to the search for hydrotechnical solutions to solve this issue.

British Vice Consul in Galaţi, Charles Cunningham, mentioned that: "*In December 1855, during a storm at Sulina's mouth, 24 ships and 60 barges had failed or sank, and nearly 300 people were perishing. Most of the shipping vessels remained in front of the mouths of the Danube and the goods were transhipped with the help of the barges*".

In 1857, the European Commission of the Danube asked Hartley for examining the three branches and recommend one for navigation. Following discussions on various variants, ECD decided in 1865 to begin work on the Sulina branch.

His proposed solution, which has long been challenged, was the construction of "jetties" (seashore perpendiculars, pushed wide to the mouths of the river). He first visited the mouths of the Oder, Vistula and Rhone rivers that had such structures and did not reach the purpose for which they were created. On his return, Hartley realized that his solution was the best and he further supported his point of view.

After the completion of the first part of the works at the Danube mouth, namely, the deepening of the Sulina bar, the second major stage was the regulation of the Sulina branch. After Charles Hartley's departure in 1871, the works were taught to be executed by the next engineer of ECD Karl Henrich Leopold Kühl.

All of the ten major cuts of the Sulina branch were made by this engineer, according to Hartley's plans and under his close supervision. Although he did not work here, Hartley spent two months a year, in the spring, supervising his plans to be put into practice.

The initial jetties (temporary and then permanent) started in 1858 and were completed in 1872; the jetties measured a total length of approximate 2,600 m: the northern jetty 1,600 m and the southern jetty 1,000 m (Hartley, 1862, 1873).

With the return of Dobrogea, after the Independence War (1877-1878) to the Kingdom of Romania, he became a full member of the European Commission of the Danube.

The next step for elongation of the jetties was taken in 1925, due to navigation problems. This performed in two stages: 1925-1932 and 1933-1937.

If the first stage was dedicated to consolidating the old jetties to prevent complete obstruction of navigation in the area, the second stage was extremely important because it involved changing the direction of the jetties, as counteract to high sediment deposition rates in the Musura Bay.

The jetties were elongated further after 1944 in two periods: 1944-1956 with an extension of 400 m and 1956-1982 with an extension of 3,000 m. The jetties currently measure 9,300 m from the point where the construction works started in 1858.

The mouth of Sulina branch - today

With the European Commission of the Danube taking over the Danube mouths, the old Turkish lighthouse in Sulina was restored, and two new entrance lighthouses were built downstream of the city, on the right bank and the left bank of the Sulina channel. In 1922, extensive works of extension of the Sulina channel led to disabling the two headlights because they were no longer positioned at the entrance to the canal (Fig.3) (http://www.primaria-sulina.ro). The lighthouse in the city continued to function even after the European Commission of the Danube was dissolved in 1938.

At the far end to the Black Sea, on the right jetty is the new lighthouse of Sulina. In the 1970s and 1980s, it was decided to build a modern lighthouse, near the end of the southern seashore, that would allow the guiding of large draft ships. It was put into operation in 1983, and in 1996 it was taken over by the Maritime Hydrographic Directorate (Fig. 4).

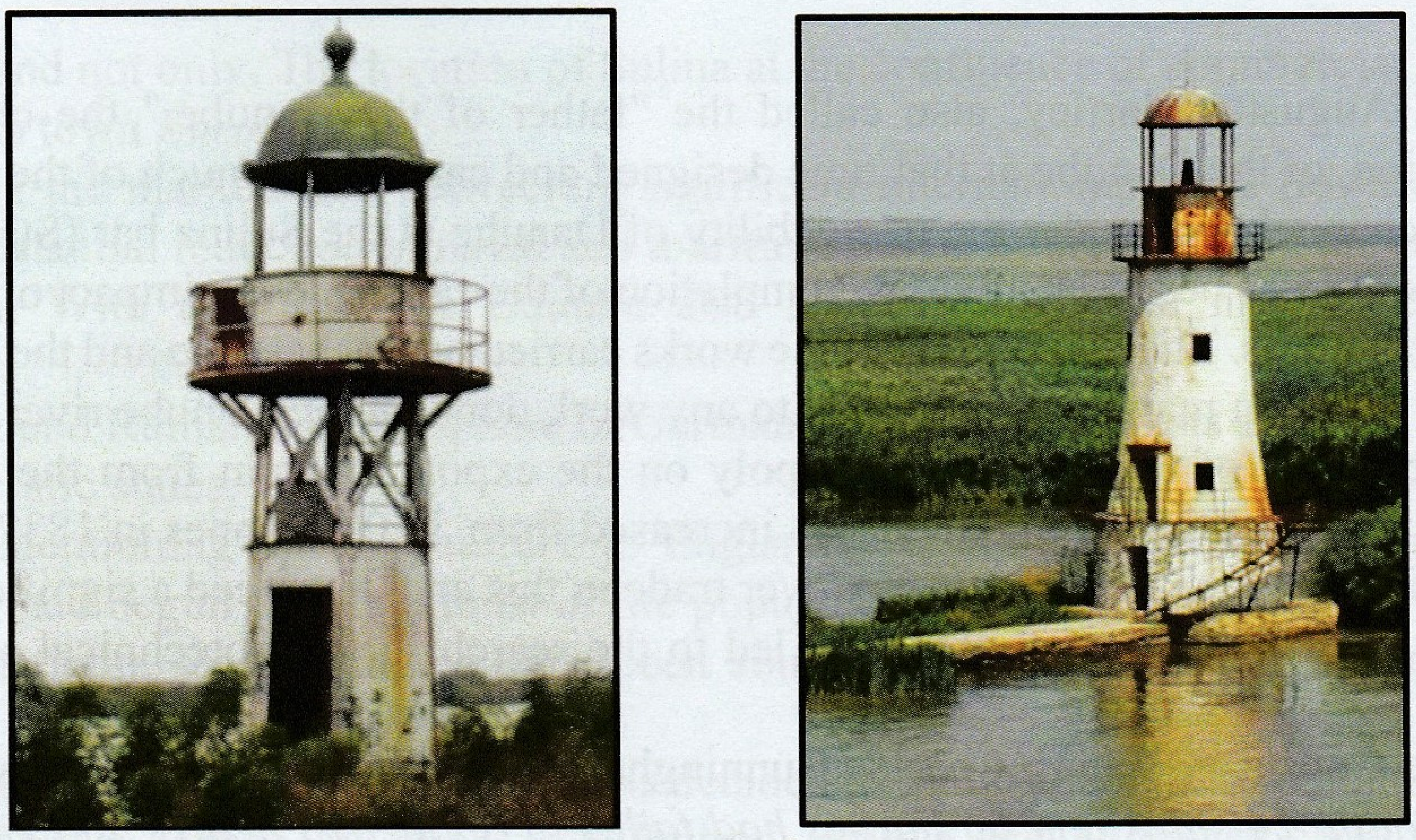

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Fig. 3 - Old entrance lighthouses on the left bank (b) and the right bank (a)
Source: www.primaria-sulina.ro

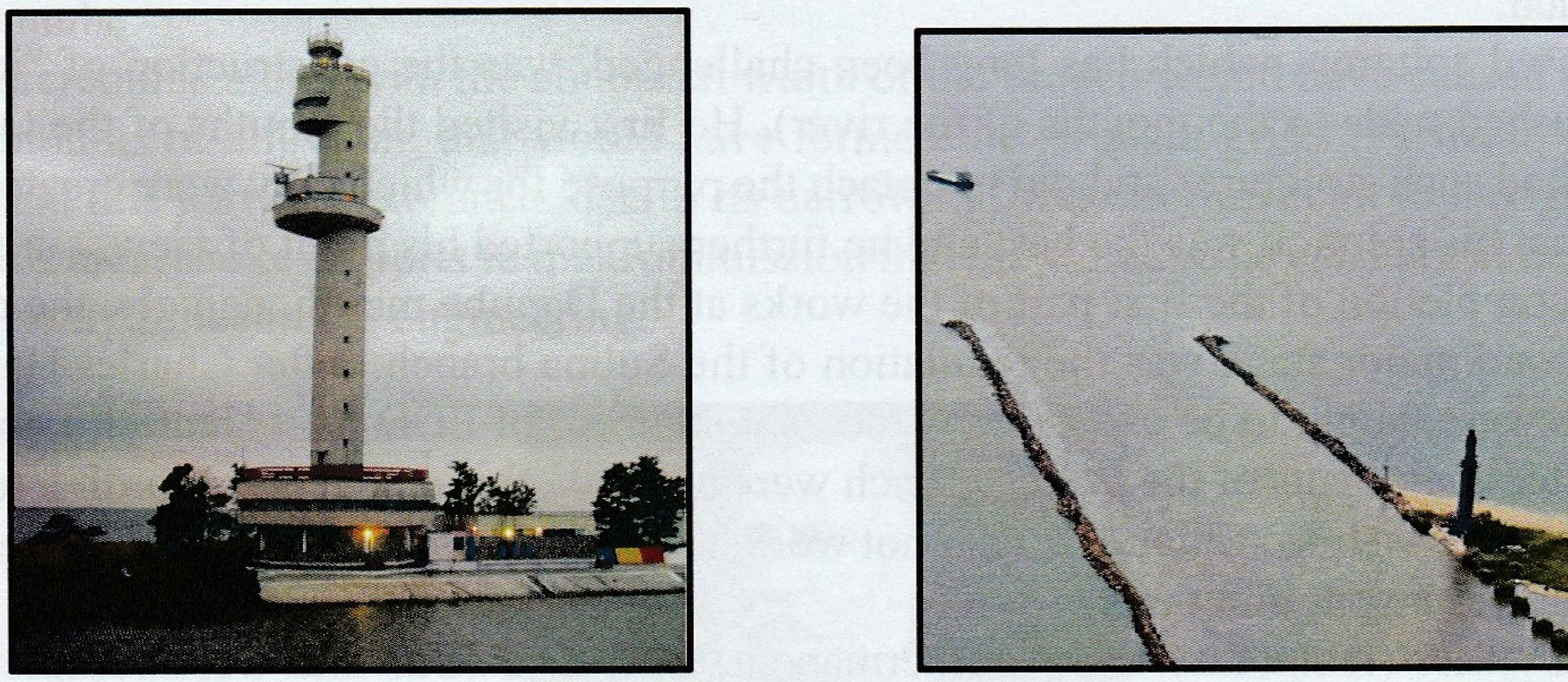

Fig. 4 -The new Sulina lighthouse
Source: www. amfostacolo.ro/imf.php?i=8483

The jetties divided the area into two sections. The northern one (Musura Bay), where sediments transported from the north are blocked by the jetties, has been subject to rapid sedimentation. A spit lateral island was formed several decades ago (Fig. 5). This spit island has evolved very quickly to the SW (elongating with about 3 km south-wards and moving west-wards with about 1.5 km during the past 20 years). This spit has closed the bay, which has now been transformed into a lagoon with two inlets (Stănică *et al.*, 2007).

Fig. 5 - Island formed in Musura Bay
Source: authors

As for the overall evolution of the Musura Bay, there is a significant reduction in the severity of the northern sector since the early 1990s due to a decrease in leakage on the southern branch of the Old Stambul lobe. However, given that the depths in Musura Bay are very small, -0.5 ... -2 m, a continuation of the clogging process is expected.

The new barrier island of Musura Bay was born in the shadow of the northern submerged rock of the Old Stambul branch, so the wave energy progressively increases to the south where the most active processes are also distinguished.

From the comparative measurement of a satellite image of the position of the barrier-island of Musura Bay, there is an elongation to the south of 1,830 m (5,9 km total length in 2002) between 1988 and 2002, which means an average rate of 130 m/year. The island is withdrawn at rates of 55 and 25 m/year in the southern and northern parts, respectively (Vespremeanu, 1989; Vespremeanu and Ştefănescu, 1988).

Marine currents and bathymetry of the Danube mouth area at Sulina

Generally, the Black Sea currents are influenced by winds, river water flow, water density distribution, coastline contours and seafloor relief. The main factor determining the surface current system is the wind.

The mainstream area is 2 to5 nautical miles off coastline, has a width of 23 to 35 nautical miles and surrounds all the sea. In this area, the currents are characterized by a relatively stable regime and the fact that they are very little influenced by the contours of the coast.

The current speed is 0.5 to 1.2 Kt, but in the condition of strong winds and during storms, it can reach up to 2 to 3 Kt. In the central area, currents go along the coast in the general sense counter clockwise. In sporadic cases, the wind can reverse the sense of currents; in this case, the current has an unstable direction and, after the wind that caused this change has stopped, the current quickly returns to the old direction. Due to the influx of continental waters, especially in the spring and early summer, the current speed predominant increases to 0.8 to 1 Kt and the current becomes more stable.

Circular currents can be better observed in golfs and bays, where they move clockwise when the main current is in the normal direction and counterclockwise when the main current is in the reverse direction. The main currents of the rectilinear coast have the same direction as the main current. The circular current velocity is usually 0.2 to 0.5 Kt., and near the rectilinear coast a value of 0.5 to 0.6 Kt is observed.

Since 2000, the Maritime Hydrographic Directorate has been conducting annual oceanographic and hydrographic surveys traversal to the mouth of Sulina branch, to carry out measurements of sea currents and oceanographic parametres as temperature, salinity, pH, etc.

The analysis of the 2011-2012 measurements revealed a preponderant marine current direction from S-S-E with a speed value of between 1.8 to 2.2 km/h on the surface and 0.8 to 1.2 km/h at depths higher than 20 m (xxx, Report 2011, 2012); at the same time, along with the current measurements, bathymetric measurements were made which reveal a spectacular dynamics of the submersible relief from the river mouth (Fig. 6).

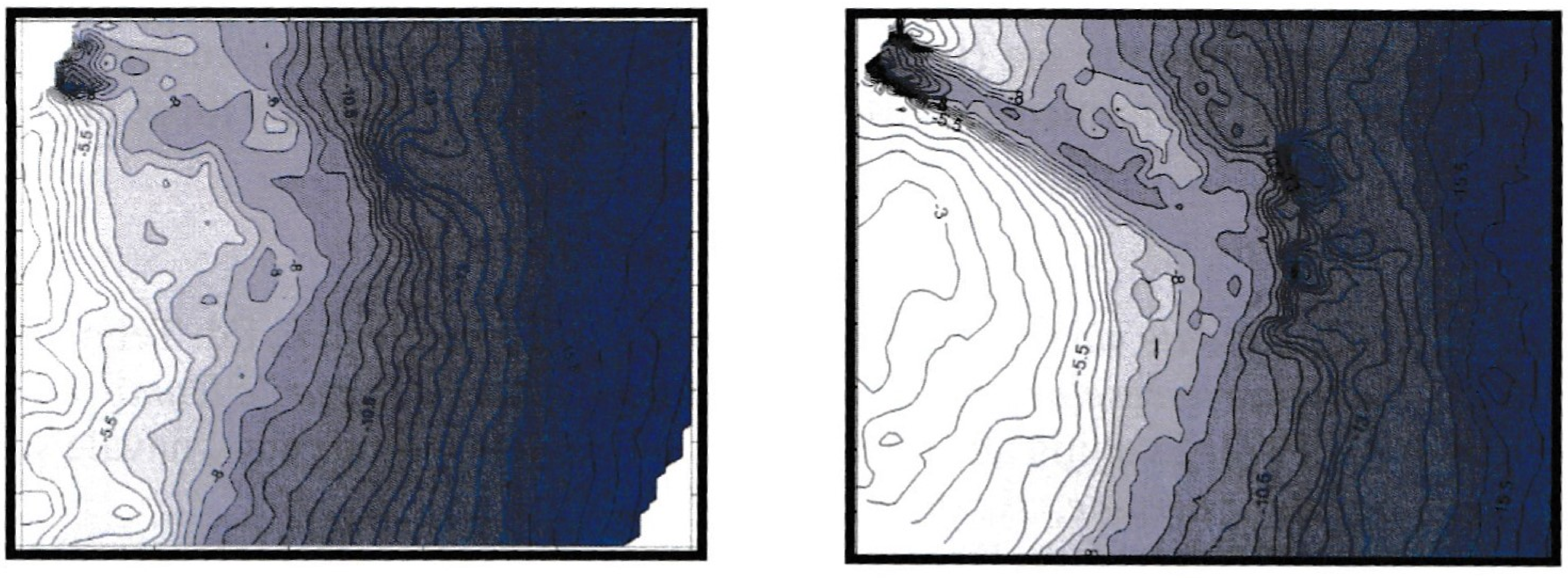

Fig. 6 2D model bathymetry (left- 2012, right-2011)
Source: authors

A conclusive example are the years 2011-2012. For 2011, due to hydrographic data processing, it was noticed a substantial evolution of the 10 m and 20 m the bathymetrics to S-E direction, compared to the hydrographical data 20 years ago (xxx, 2012) (Fig. 7 a and b).

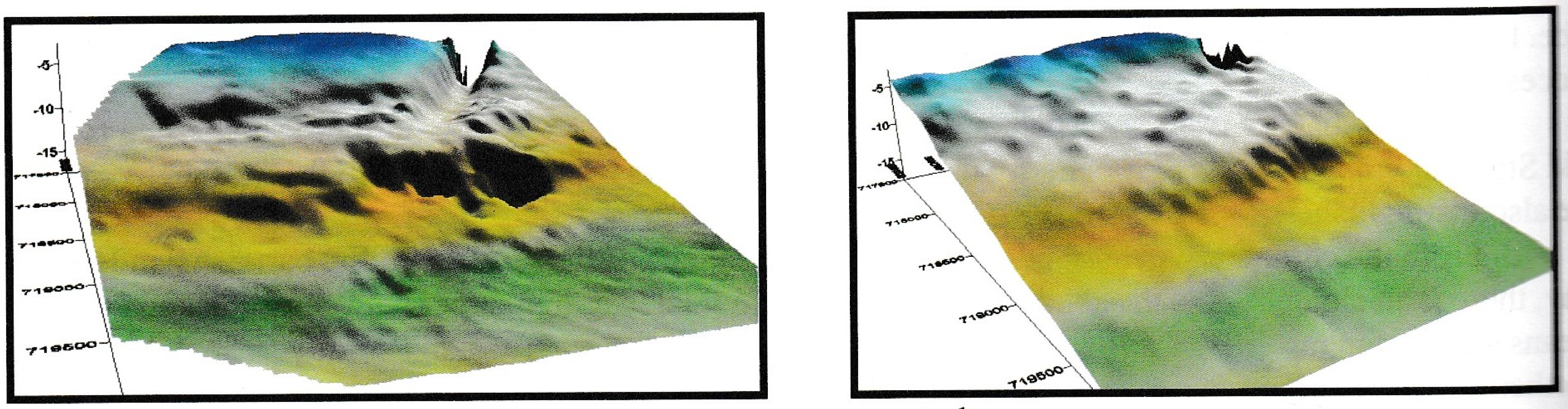

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Fig. 7 Bathymetric charts of the Danube river mouth - Sulina area (a-2011) (b-2012)
Source: authors

For 2012, due to the hydrographic data processing, for the same area, massive displacement of the alluvial layer in SSE direction was observed (xxx, 2012) (Fig. 8).

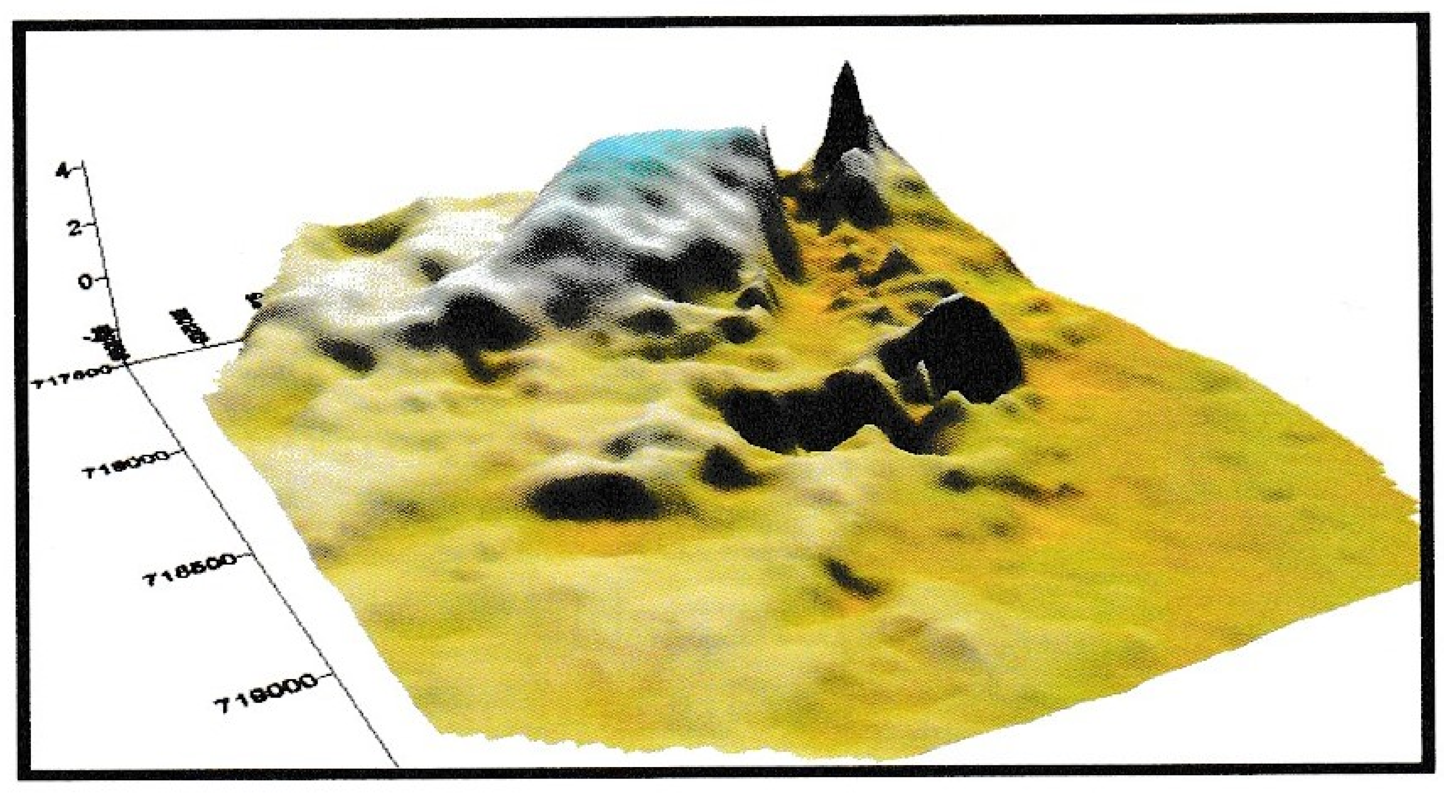

Fig. 8 The difference in the volume of alluvial between 2011-2012
Source: authors

Conclusions

The history of Sulina town and the Danube river mouths, reveals the particular importance of this area both in national and European context. Sizeable hydrotechnical construction has shaped the specificity of the area over time and represented a continuous struggle of man with nature. The lessons of history can show us how should we approach this fight in future. Nowadays, by modern means, we try to understand as much as possible the specific features of this spectacular area from all points of view.

An essential element is the dynamics of deposition of alluvia. This is due to the combined actions of the Danube River's discharge into the sea (E-SE direction), the specific marine current (S-SE direction), as well as currents and waves that are formed as a result of wind evolution, especially those in the N-NE direction.

References

Almazov A.A. et al., 1963, *Zona de vărsare a Dunării. Monografie hidrologică*, Ed. Tehn., Bucureşti, 396 pp.
Ardeleanu C., 2008, *Evoluţia intereselor economice şi politice britanice la gurile Dunării*, Ed. Istros, 135 pp.
Bondar C., Papadopol A., 1972, Evoluţia albiei Canalului Sulina, transporturi auto, navale şi aeriene, *Rev. Transp. auto, navale şi aeriene*, II, 19, 3, 144-147.
Bondar C., State I., Cernea D., Harabagiu E., 1991. Water flow and sediments transport of the Danube at its outlet into the Black Sea. *Meteorol. Hidrol.*, 21, 1, 21-25.
Bondar C., Panin N., 2000, The Danube Delta Hydrologic Database and Modeling, *Geo-Eco-Marina*, 5-6, 5-53.
Driga B.V., 2004, *Delta Dunării - Sistemul circulaţiei apei.* Casa Cărtii de Ştiinţă Cluj-Napoca, 256 pp.
Hartley C.A., 1862, Description of the Delta of the Danube, and the works, recently executed, at Sulina Mouth, Minutes of Proceedings of the Institution of Civil Engineers, XXI, 277-308.
Hartley C.A., 1873, On the changes that have recently taken place along the sea coast of the Delta of the Danube, and on the consolidation of the provisional works at the Soulina Mouth", Minutes of Proceedings of the Institution of Civil Engineers, XXXV, 201- 225.
Panin N., Jipa D., 2002, Danube River sediment input and its interaction with the north-western Black Sea estuarine, *Coastal and Shelf Science*, 54, 3, 551-562.

Rădoane M., Rădoane N., 2005, Dams, sediment sources and reservoir silting in Romania, *Geomorphology*, 112-125.

Stănculescu G.R., 2009, Recenzie - Dintr-o biografie a inginerului englez Sir Charles Hartley "părintele Dunării", 28.

Stănică A., Dan S., Ungureanu V.G., 2007, Coastal changes at the Sulina mouth of the Danube River as a result of human activities, *Marine Poll. Bull.*, 55, 555-563.

Vespremeanu E. (1989), Beach morphometry and morphodynamics of the north-western Black Sea delta shore, *Anal. Univ. Bucureşti, Geografie,* XXXVIII, 1-99.

Vespremeanu E., Ştefănescu D., 1988, Present-day geomorphological processes on the Romanian delta and lagoon littoral of the Black Sea, *Anal. Univ. Bucureşti, Geografie,* XXXVII, 85-91.

Wong H.K., Panin N., Dinu C., Georgescu P., Rahn C., 1994, *Morphology and post-Chaudian (Late Pleistocene) evolution of the submarine Danube fan complex*. Terra Nova, 6, 502-511.

****Report from oceanographic and hydrographic survey conducted in the Sf. Gheorghe - Sulina area,* 2011 - Maritime Hydrographic Directorate.

*** *Report from oceanographic and hydrographic survey conducted in the Sf. Gheorghe - Sulina area*, 2012 - Maritime Hydrographic Directorate http://www.primaria-sulina.ro