

A cartographical perspective to the engineering works at the Sulina mouth

Ștefan Constantinescu^{1*}, Liviu Giosan², Alfred Vespremeanu-Stroe¹

¹Department of Geography, University of Bucharest, N. Bălcescu No. 1, Bucharest, Romania

²Coastal Systems Group, Department of Geology and Geophysics, Woods Hole Oceanographic Institution, 360 Woods Hole Road, Woods Hole, MA 02543, USA

Abstract

From 1856 to 1939, the European Commission of the Danube (ECD), was responsible for technical surveys at the mouth of Sulina arm. During this period, ECD prepared general maps of Danube Delta as well as detailed charts for all the Danube mouths: Chilia, Sulina and Sf. Gheorghe (St. George) that were published in various reports or atlases. ECD used a local grid network benchmarked at Sulina, divided in 500 feet units. The reference point was the old lighthouse located on the right bank of Danube. After the Second World War, the Romanian authorities elaborated new cartographical products using the Gauss-Kruger projection or Stereo-70 like national grid. Our goal is to generate a cartographical background database necessary for refining the coastal evolution model of the Sulina mouth. To handle the large number of available maps, we chose GeoNetwork like a solution for catalog service, indexing and defining metadata. The service is operating at geo-spatial.org.

Key words: Sulina, Danube, European Commission of Danube, Black Sea

Introduction

Before 1856, when the European Commission of the Danube (ECD) was established, navigation through the Sulina mouth was difficult due to natural obstacles, hindering the trade of Danubian states. However, the Sulina was at the time and remains today the only arm of the Danube that is navigable for maritime ships. In the XVII and XVIII centuries the optimal depth for navigation was less than 3m. Sailing ships coming from the Black Sea traveled almost 6 weeks from the mouth to Galati, the most important port in Moldavia (Petrescu, 1957). It was, probably, a long way fraught with difficulties in navigation and under the threat of piracy. In 1784 the Ottoman Empire invited two French officers, Conte de Chabanne and Brentano, to make a project for navigation through the Sulina mouth. After a year, a technical Turkish committee considered the French project too expensive and recommended another solution: to build a wooden dike at the river mouth. The work began in June 1786 but for economic reasons, the Empire ordered ceasing of them soon thereafter. A rudimentary fence placed at the mouth was used later, in order to maintain a narrow channel by increasing the speed of the current, but the effects were minor.

The suggestion to establish a European Commission belongs to Charles Cunningham, the vice-consul of United Kingdom in Galati (Krehbiel, 1918). The main objective of the ECD was to facilitate a free commerce and to maintain an optimum depth for ships at the Danube mouth.

The first task of the Commission was to make preliminary studies, primarily maps, necessary to understand the natural conditions in the Danube Delta. Before the Treaty of Paris (1856), there were no accurate maps, hydrographical data or topographical surveys on the Danube (Sturza, 1904). An important problem that needed to be studied was the formation of bars at the mouths of Danube arms. The survey works were conducted by Sir *Charles Hartley*, an English engineer with experience in hydrological and coastal projects. He was helped by Capt. *T. A. B. Spratt* from Royal Navy, Austrian engineers *Wex* and *Pasetti*, the Director of Rhine River from Coblenz *de Nobiling* and by a German engineer *Mr. Richratt* (Sturza, 1913).

* E-mail: stefanc@geo.unibuc.ro

An impressive number of projects were elaborated for the entire Danube Delta coast with detailed surveys for all the Danube river mouths: Chilia, Sulina and Sf. Gheorghe. Based on studies, prepared by ECD until 1858, a new International Technical Commission established in Paris, decided that the best solution for navigation into the Black Sea would be the mouth of St. George arm (CTI, 1858). Later the budget for this project was considered too expensive (17.500.000 francs) and European Commission decided to postpone it until funds were available. Meanwhile, Hartley conducted preliminary works at the Sulina mouth. Because the results turned out unexpectedly good, ECD decided to make the engineering works at Sulina permanent and abandoned all plans for the development of the mouth of Sf. Gheorghe. This decision was published in a memoir signed by all members of the Commission: *Memoire sur les Travaux d'amelioration executes aux Embouchures du Danube* (Commission Europeene du Danube, 1867). The memoir includes an appendix signed by Charles Hartley, which is in fact a report of the engineering works performed between 1858 -1865. These provisional works, consisting of two piers (or jetty system) forming a seaward prolongation of the fluvial channel, started in 1858 and were finished in 1861 (Hartley, 1862).

After 1872, Sir Charles Hartley became a consulting engineer to the Commission and he was succeeded as a resident engineer by Charles Kuhl. In his report (Kuhl, 1891) presented a brief of the works executed by the Commission on the Sulina branch: groynes and training banks, revetments, straightening river banks by cutting off projecting points, cuttings and dredging on shoals. A general plan of the branch with all the cutting projects is presented within the report. Because the main objective of ECD was focused on navigation aspects, field data acquisition was focused on the Sulina branch where accurate topographic surveys were performed. In contrast the Chilia and Sf. Gheorghe branches were treated more like reconnaissance studies. A special emphasis was put on surveying the shoreline and offshore areas of Danube Delta. The territory south of the Danube main branches and Lake Razelm is represented on maps in a descriptive manner with no accurate topographical surveys. From a geodesic point of view, the first accurate map for the entire Danube Delta was to be elaborated later between 1909 -1911 by the Romanian engineer Gheorghe Vidrascu.

Cartographic Material from the Preliminary Work Phase (1856-1861)

Before starting its engineering works, the ECD commissioned a general map of Danube Delta and detailed charts for all the river mouths. This project was entrusted to Cpt. Thomas Spratt. The result was published first to accompany the *Report of Capt. Spratt* dated 8 Aug. 1856. These consist in 8 detailed plans, numbered 1 to 7a, focused on the Chilia, Sulina and Sf. Gheorghe mouths. For the present study we used plan number 4, entitled *Sulina bar and mouth*, published at 23 April 1857, a survey conducted by Lieutenant C.R. Wilkinson and Mr. Millard.

The Hydrographic Office printed an official version of the chart on April 23, 1857. There is no mention regarding the geographical coordinate system and no information about the ellipsoid, datum or projection. For the charts prepared after the Spratt edition, ECD used the position of the old lighthouse in Sulina to support the origin of a local grid network (the old lighthouse was actively used until 1984 when the present lighthouse was built). For this reason, believe that Capt. Spratt used the same point for his surveys, a few years before. The lighthouse was the highest building in town at the time, which is an additional argument for its use as a geodesic reference point. A cross-section profile of the mouth bar at Sulina is also presented on the map, using a vertical scale in feet.

An updated version of the Spratt map was published by the Admiralty in October 17, 1861. This contains geographic coordinates system with the prime meridian set on Greenwich. The map scale is 1:166400, soundings are in feet and the projection (not specified on map) is probably Mercator, like all the charts produced by the British Admiralty.



Fig. 1 The plans elaborated by Capt. Spratt in 1856 for Danube Delta.



Fig. 2 Plate No. 4 showing the Sulina mouth in 1856, a survey conducted by Lieut. C.R. Wilkinson and Mr. Millard, under the direction of Capt. Spratt.

Until 1968 Admiralty charts were published with fathoms and feet as the units for depth and feet as units for heights. From 1968 a new procedure for conversion in metric system was introduced (UKHO, 2007). From 1839, the British Admiralty used a number system to identify each chart. These numbers are printed at the bottom right hand corner of each sheet. For example the map called *Delta of the Danube from 1856, a survey of Capt. Spratt*, has number 2835. Using the *Catalogue of Admiralty Charts and Publications* it is possible to find modifications or updates for every chart (Dunsterville, 1864). To describe a chart, the British Admiralty used the following details: Number of the chart; Title; Date of Printing (if any); Date of Publication; Date of last New Edition (if any); Date of last Large Correction (if any); Number of last Notice to Mariners. Short descriptions for every river mouth are placed on the map in order to give a general overview of natural conditions. For the Sulina mouth, Capt. Spratt wrote: *“The Piers at Sulina Mouth were completed in Augt. 1861 at which time the depth was 17 ft. It is liable to change & will generally be least about June, July & August [...]”*. Other information is provided for navigation in a separate category, called *Caution: as the effect of Piers will probably be the extension and shoaling of the Spit off the entrance; and also as the Buoy is liable to be swept away by storms Captains of vessels are conditioned to kept well to the northward in entering or leaving the port.*

The sounding method consists in drawing profiles that cover the entire area. Where the depths are irregular the examinations were usually conducted on a larger scale than the rest of the survey (UKHO, 2007). The benchmark for bathymetrical surveys is related to the zero level of Sulina, which is at 4.88 feet bellow the point established in 1857 at the base of the lighthouse (Commission Europeene du Danube, 1886). This level has been used later by I. G. Vidrascu.

In a report of Ch. Hartley from 1862 is another important map: *Sulina mouth of Danube*, a Russian Government Survey from 1829. The map uses a local grid network (divided in 500 feet rectangular units) witch was overlaid later by the English engineers, in order to have comparable data. The depths are in feet, using bathymetry contours without sounding points. Even if the map contains only few isobaths (10, 12, 15, 20 and 30 feet), this material is a reliable source for further studies. Hartley did not hesitate to call this map *“the earliest authentic document extant which shows the state of Sulina mouth”*. After that, he attempted the first comparative study of the evolution of the mouth between 1829 and 1857. Another statement supporting the idea that old lighthouse was the principal point of the English local grid network is the following sentence: *On laying off an imaginary line, directly to the east of the Old Lighthouse, and using it as a datum line for the purpose of measurement, it appears that whilst the coast line remained...*

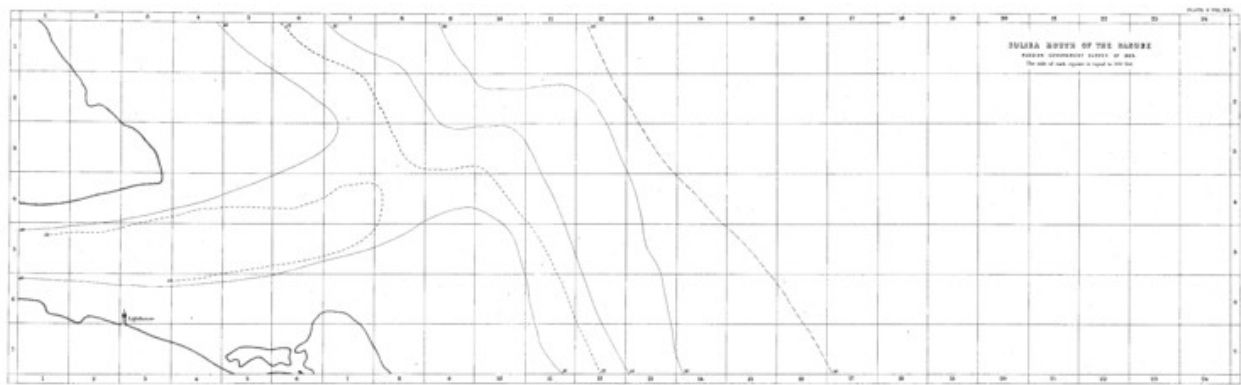


Fig. 3 The map from 1829 based on a Russian Government Survey

One year later, in July 1857, a new survey of the Sulina mouth, conducted by R. Hansford, was finished. Major Stokes (the English delegate to the ECD) describes in his autobiography that Mr. Hansford was an *accurate and trustworthy surveyor of water-ways* (Stokes, 1998). Another engineer who came with Hartley was Mr. Mein, but in the same autobiography, Stokes describes him as being *inefficient*. For these reasons, the name of Hansford is passed on many maps published by the ECD in the next years, while the name of Mein will never appear again. Robert Hansford is mentioned later in a report of Hartley from 1862, as *the skilful surveyor of the Commission*.

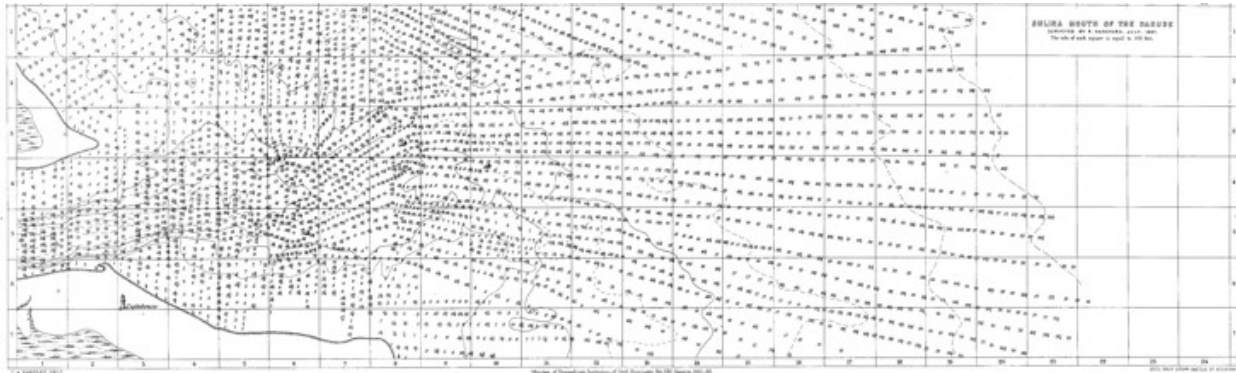


Fig. 4 A detail map of the Sulina mouth, surveyed by R. Hansford (July 1857)

Cartographic Material from the Maintenance Phase (1861-Present)

Starting on April 21, 1858 the preliminary engineering works at the Sulina mouth lasted until July 31, 1861, with stoppage periods only during winter seasons. In 1861 the length of northern pier was 4650 feet (1417m) and southern pier had 3000 feet (914m). The depth on the mouth bar remained stable at 17 feet (5.1m) until December 1862. In the 1861 survey, profiles were arranged along the direction of entrance to the mouth.

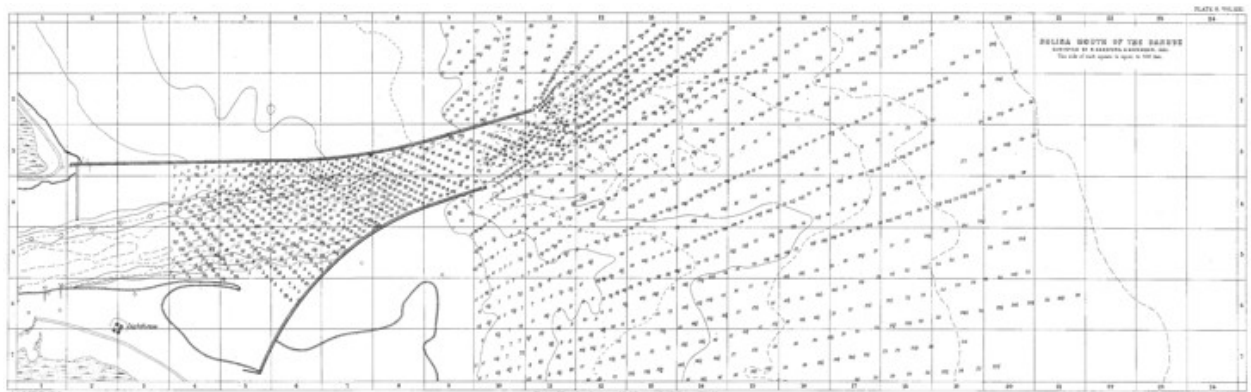


Fig. 5 A detail map of the Sulina mouth after completing the preliminary works, surveyed by R. Hansford (November 1861)

Political changes in Romania in mid 19th Century boosted the engineering works at the Sulina mouth. In the second trip of King Carol I on the Danube (1867), he was accompanied by a French professor, M. Ernest Desjardins, who published previously a study about the Rhone River. His intention was to compare the natural conditions between Rhone and Danube and to offer his experience for Romanian authorities (Desjardins, 1868). King Carol discussed with Mr. Desjardins a project for a new harbor, necessary for the Romanian commerce. Repeated meetings were held with members of the Commission and the Romanian Government supported the projects developed on the Danube.

From this moment ECD entered into a new phase with the main task to maintain an optimal depth and extending the length of piers. The huge success of these constructions was evident. The increasing number of vessels passing through Sulina has strengthened the Commission's importance. After 9 years of existence, on November 2 1865, a statement of account is published (Sturza, 1913) where we can find all the works enterprise: construction of piers at the mouth, correcting the course of the arm, establishment of a buoy system, removing wrecks from the shipping lane, construction of a new lighthouse at Sf. Gheorghe and a new marine hospital in Sulina etc. For these results the operating period of the Commission has been extended in 1865, 1871, 1883, 1904 until 1939, when the technical works were continued by a Romanian institution (Directia Dunarii Maritime or Maritime Danube Directorate). Since 1948, when a new Commission of Danube was established, the responsibility of navigation between Braila and Sulina belongs to Fluvial Administration of the Lower Danube (AFDJ). Maps from Romanian authorities are in Gauss-Kruger projection, or use Stereo-70 for the national grid.

Cartographic materials of the first ECD have been published regularly until 1939, in order to show exactly the changes in depth at the mouth. Some of them are published in separate reports of the engineers in charge, others appear in memoirs or atlases. One of the most important is the 5th report of ECD (Commission Europeene du Danube, 1886). For the Sulina mouth, English engineers elaborated 43 charts that cover the interval from 1872 to 1886. A sketch with 8 comparative profiles (called from A to H) and 5 delimited areas, describes the morphodynamics of the mouth bar, between 1857 and 1886. Another chart presents the variation of liquid/solid discharge and the velocity of river current from 1872 to 1886. A general map of Danube Delta is divided in five plates, without Razelm Lake and the surroundings areas, south of Sf. Gheorghe arm. This map dates from 1872 with a revision in 1886.

Defining metadata for cartographical products.

The impressive number of maps for the Sulina mouth, more than three for every year, makes analysis process laborious. Our purpose is to create a cartographical background database necessary for a coastal evolution model of the Sulina mouth. At the moment many of the available maps contain still uncertain information. The first step is to index, catalog, and define metadata in ISO19115 standard and distribute all maps using web services. For our study area we have been integrating 70 cartographical products, which are web delivered via geo-spatial.org.

geo-spatial.org is a Romanian geoportal which promotes sharing of geoKnowledge and geoData based on the OGC standards. The website, developed only with opensource solutions, includes geoportal specific functionality, like the catalog and searching service (based on Geonetwork).

For each map, the following steps are taken: georeferencing, digitization and Digital Elevation Model development. We intend to integrate all 43 plates of the 1886 atlas with other maps published in all available reports of the CED (1867, 1873, 1906). In a first phase we indexed the cartographical documents to generate an open space for sharing the knowledge about Sulina mouth using the GeoNetwork software. At this moment the service is operable: earth.unibuc.ro:8080/geonetwork.

Conclusions.

From 1856 to 1939 the ECD was responsible for bathymetric and hydrographic surveys at the mouth of Sulina branch of the Danube. New engineering works were carried out with good results in improving commercial navigation. Precise bathymetrical surveys were performed, using a local grid network with the old Sulina lighthouse as a geodesic benchmark.

At present most of the existing maps of the Sulina mouth are indexed using GeoNetwork software, a standardized opensource catalog application used to manage spatially referenced resources on the web.

For many cartographical documents this method can be a reliable depository for indexing, searching and editing metadata, especially for historical maps, using OGS standards. This is the first step in defining a cartographical background database, necessary to evaluate further the morphological evolution of the Sulina mouth.

Bibliography

Commission Europeene du Danube. (1867). : *Memoire sur le Regime administrative etabli aux Embouchures du Danube par la Commission Europeenne charge d'en ameliorer la Navigabilite, en execution de l'article 16 du Traite de Paris du 30 mars 1856*. Galatz: Imprimerie de la Commission Europeenne du Danube.

Commission Europeene du Danube. (1873). *Memoire sur l'Achevement des Travaux d'amelioration executes aux Embouchures du Danube par la Commission Europeenne instituee en verdu de l'article 16 du Traite de Paris du 30 Mars 1856. Avec 3 cartes jointes au texte et un atlas de 59 planches; faisant s.* Leipzig: A. Brockhaus.

Commission Europeene du Danube. (1886). *Memoire sur les Travaux d'Amelioration du Bas-Danube, executes pendant la periode 1873 a 1886 par la Commission Europeenne instituee en verdu de l'article 16 du Traite de Paris du 30 Mars 1856. Avec 4 Cartes, 37 Tableaux et 28 Etats joints au texte. Compl.* Galatz: Imprimerie I. Schenk.

Commission Europeene du Danube. (1867). *Memoire sur les Travaux d'amelioration executes aux Embouchures du Danube par la Commission Europeenne instituee en verdu de l'Article 16 du Traite de Paris du 30 mars, 1856. Accompagne d'un Atlas de 40 Planches*. Galatz: Imprimerie de la Commission Europeene du Danube.

Commission Europeene du Danube. (1906). *Note sur les Travaux Techniques de la Commission Europeenne du Danube, 1856 a 1905*. Bucharest: Socek.

Commission Technique Internationale (1858). *Rapport de la Commission Technique Internationale convoquee a Paris pour l'examen des questions relatives a l'amelioration des Bouches du Danube*. Paris: Imprimerie Imperiale.

de Marigny, T. M. (1836). *Voyage d'Odessa au Danube jusqu'a Ismail fait en 1835 et description de la branche de Soulina*. (C. Arthus-Bertrand, Ed.) *Bulletin de la Societe de Geographie , Deuxieme Serie (Tome Cinquieme)*, 352-372.

Desjardins, E. M. (1868, Janvier-Juin). *Note sur la Mission de M. Ernest Desjardins aux bouches du Danube*. *Bulletin de la Societe de Geographie, Paris* , pp. 87-91.

Dunsterville, E. (1864). *Admiralty catalogue of charts, plans, views and sailing directions*. London: George E. Eyre and William Spottiswoode.

Hartley, C. A. (1862). *Description of the Delta of the Danube and of the Works recently executed, at the Sulina Mouth*. *Minutes of Proceedings of the Institution of Civil Engineers* , 277-308.

Krehbiel, E. (1918). *The European Commission of the Danube: An Experiment in International Administration*. Political Science Quarterly, vol. 33, No. 1 , 38-55.

Kuhl, C. H. (1891). *The Sulina Branch of the Danube*. Minutes of Proceedings Inst. C. E. , 238-247.

Petrescu, I.,G., (1957), *Delta Dunării. Geneză și evoluție*, Ed. Științifică, București.

Stokes, J. (1998). *Autobiography*. http://members.fortunecity.com/78blencowest/j_stokes.htm

Sturza, D. A. (1913). *Insemnătatea Lucrărilor Comisiunii Europene dela Gurile Dunărei*. Extras din Analele Academiei Române, Seria II, Tom. XXXV . București: Librăriile Socec.

Sturza, D. A. (1904). *Recueil de documents relatifs a la liberte de navigation du Danube*. Berlin: Puttkammer & Muhlbrecht.

United Kingdom Hydrographic Office (2007), *Use of Admiralty Charts and Publications*, Extract from the Mariners Handbook (NP 100), Edition 1.3