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# PUIULET LAKE DANUBE DELTA– BATHYMETRICAL CHARACTERISTICS

**Daniel Constantin Diaconu[1], Emanuel Mailat[2]**
Faculty of Geography, University of Bucharest, Romania, diaconudc@hotmail.com
Water Directorate Arges Vedea, Piteşti, Romania, emanuel.daav@ yahoo.com

**Abstract**

The study of the bathymetrical characteristics of lake basins aroused interest long ago, leading to a continuous evolution of the investigation methods. Technical instruments and processing of data gathered on site have evolved and the results can be observed in the accurate reproduction of lake basin morphology. The lakes in the Danube Delta have suffered spectacular changes throughout the years, both in their number and the morphometrical characteristics. The morphometrical analysis of the lakes can offer the premises for identifying their developing tendency.

**Keywords:** lake, sediments, bathymetric

## 1. INTRODUCTION

The genesis and evolution of the Danube Delta has preoccupied the scientifical world from the beginning of the 19th century. The historical documents, scientifical works and maps which were published and are referring to this area prove our interest for the deciphering of the evolutionary mystery of the newest Romanian land. Without being able to enumerate all the scientists that studied this area, we mention the following: Gh. Murgoci (1912), Gr. Antipa (1914), C. Brătescu (1912, 1922), Emm. De Martone (1931), G. Vâlsan (1934, 1935), I. Lepsi (1924), H. Slanar (1945), V.P. Zenkovich (1956), P. Coteţ (1960), E. Liteanu şi A. Pricăjan (1961), A. Banu (1965), N. Panin (1974, 1983, 1989), C. Diaconu şi I. Nichiforov (1963), V. Stănescu (1967), Gh. Romanescu (1996), P. Găştescu (1998), B. Driga (2004), P. Gâştescu şi R. Ştiucă (2006), L. Tiron (2010),who emphasized different theories and details of the Danubian Delta space. The morphological aspect of the Danube delta is that of an alluvial meadow in forming process with reduced altitudes, part of which are under the level of the Black Sea. From a geographical point of view, the delta shocks by its complex scenery, its numerous ecosystems, its climate characteristics and, not lastly, by its socio-economical factors. From a morphogenetic point of view, there are many types of landform such as elevations, lowlands, erosion witnesses and sand dunes. The hydro graphic network is the one that makes the delta system function, being formed of the main Danube firths (Chilia, Sulina, Sfantu Gheorghe), the streams and canals between them (Gârla Satului, Gârla Veche, Matiţa Merhei, Perivolovca, Şontea, etc.)as well as the lakes and moors that are in a tight connection with the streams, canals and Danube firths (L. Furtuna, Matiţa, Merhei, Trei Iezere, Bogdaproste, Gorgova, Isac, Uzlina, Lumina, Puiu, Roşu). We can also encounter lakes with surfaces between tens, hundreds or thousands of hectars, whose depth varies frequently between 1-2.0 m and only in some isolated cases reaching values of 3-4.0 m (except for the lakes located on the abandoned meanders of the river where we can register depths of 7.0 m)

The evolution of the number of lakes and their surface was connected to the economical interest in the area (agriculture, pisciculture) and less to the natural factors (swamping/ eutrophications). Draining the lakes in order to obtain agricultural fields led to the disappearing of hundreds of lakes from the Danube Delta and the silting phenomenon has led to the decrease in the water volumes and surfaces. The biggest problem of the delta lakes from a morphometric point of view is not determining the average or maximum depth, but the determining of their fix shores which are highly occupied by floating reed islets that change their position under the influence of the wind and the configuration of the surface of the lake.

## 2. REFERENCE POINTS OF THE TECHNOLOGY USED IN DETERMINING AND REPRESENTING THE MORPHOMETRIC CHARACTERISTICS OF THE LAKES

Starting with 1991 when I. Vidrascu was printing the map of the Danube Delta, there appeared several representations of the space emphasizing the hypsometrical characteristics of the landform unities and of the morpho-hydrographical unities, at a scale of 1:25.000, 1:50.000, and 1:75.000.

The volume of water and alluvium coming from the main firths of Danube into the lakes, respectively coming out of them, is very important for the development of depths and surfaces of lacustrine unities. We add to this fact the influence of the hydro technical works undergone here (dikes, spillways, canals) in order to give value to the economical potential of the area.

The means to determine the morphometrical characteristics of the Delta lakes, as well as their rapid variation led to several disagreements between the map representations and the reality.

At this moment, the GPS technology allows the accurate locating of the lakes and the highly precise determination of morphometric characteristics.

The methodology of topo-bathymetry is made up of a field stage and two lab stages (one preceding the field activity, to prepare the informational support and another one to process the acquired emersed and submersed data).

During the first office stage, a project is being developed, involving a GIS map of the lake and an orthophotoplan over which several elements are being overlapped, elements whose XYZ coordinates are given.

In order to reach this purpose, a sheep folder is being formed for each group of useful elements in the field stage, such as: CSA milestones, landmarks, obstacles that can make navigation difficult, transversal profiles to guide navigation.After the preceding office stage to prepare the informational support is completed (HYPACK program and sheep folders) we can move onto the field in order to acquire data.

In the field works stage we do the topographical elevations of the banks with the total station and we probe the submersed areas by means of the sonar on the established profile lines. Acquiring the submersed data is done by the single beam. Afterwards, the measurements and distances of the topobathymetrical profiles are being processed in the office and based on this data the depth, length, width, volume and surface of the lake are being calculated, correcting or eliminating the unrealistic values. It is quite difficult to perform a GPS mapping of all the lakes in the Danube Delta because of the large number of lakes situated in this are (approximately 479 according to P. Gastescu and R, Stiuca, 2006) and of the size of their surface which would have to be covered (25,666 ha according to P. Gastescu and R. Stiuca, 2006), but also because the access to certain lakes is difficult or even impossible in certain periods of time. The advantages of such a mapping are indisputable: establishing certain reference points which would be able to offer accurate information on the way the lakes and the delta itself have evolved if the information is corroborated with those concerning the brooks and main firths of Danube.

## 3. THE MORPHOMETRIC CHARACTERISTICS OF THE PUIULET LAKE

The Puiulet Lake lies between the Caraorman elevation, more accurately the Lat Elevation and the Lumina Elevation, being hydrologically connected to the Caraorman Canal in the west, to the Macovei, Rotunda, Vatafu de Nord, Lumina and Puiu lakes in the East. Its water comes mainly from the Sulina firth through the Crisan and Caraorman Canal (between 0-50 mc/s according to P. Gastescu). It is a lake of small to average size, its surface being covered by an island as well as large unites of floating reed which moves permanently under the influence of the wind modifying the shape of the lake and blocking the access on the canals debouching in it. Because of this the elevation of the lake's surface is difficult if we would want to study its fix shore. In reality, we are practically determining the size of the water surface of the lake at this moment. Similarly to the neighbouring lakes, the average depth is approximately 1.70- 1.80 m, with some "wholes" where the depth can reach a maximum of 3.50 m. The surface of the lake resulting from processing the data obtained after the topobathymetrical elevation of July, 2012 was of 472.0 ha. On its surface there is an island of considerable dimensions as well as several floating reed formations whose surface can exceed sometimes half of the island's size. Considering the previous measurements on the Puiulet Lake and the data gathered after this campaign, we can notice that it is permanently growing (table1 and figure 2).

**Table 1 The variation in time of the Puiulet Lake surface**

| No. | Year | Surface (ha) | Difference (ha) | Time interval (year) |
|---|---|---|---|---|
| 1 | 1975 | 327* | 0 | 0 |
| 2 | 2000 | 427* | 100 | 25 |
| 3 | 2012 | 472 | 45 | 12 |

*values taken from the presentation of „Human induced hydro-morphological changes in Danube Delta, P. Gâstecu, I. Grigoras, B. Driga."

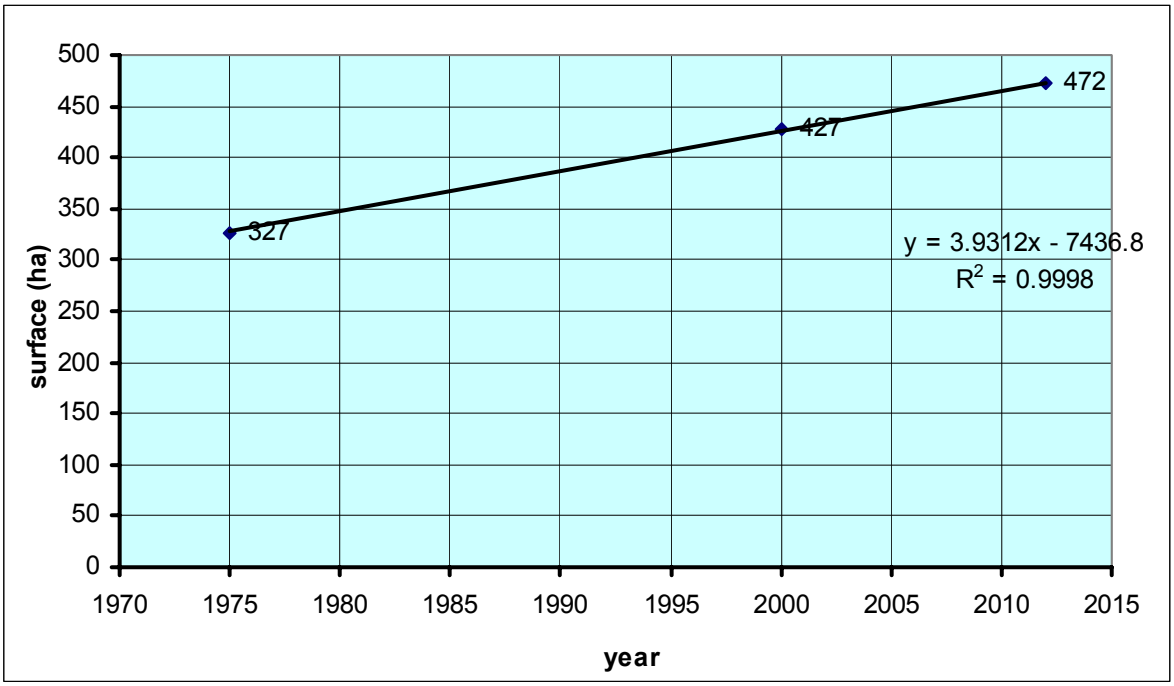


**Fig. 1 The variation of the Puiulet Lake surface between 1975-2012**

The limnimetrical key resulting from the data processing indicates the fact that up to 1.50m, the lake shows reduced variations of the water volume and surface (425,000 m³ and 329 ha), but between 1.50-2.50 m (especially during the rainy periods) they can reach much higher values (3.55 mil. m³ and 493 ha) (fig.2).

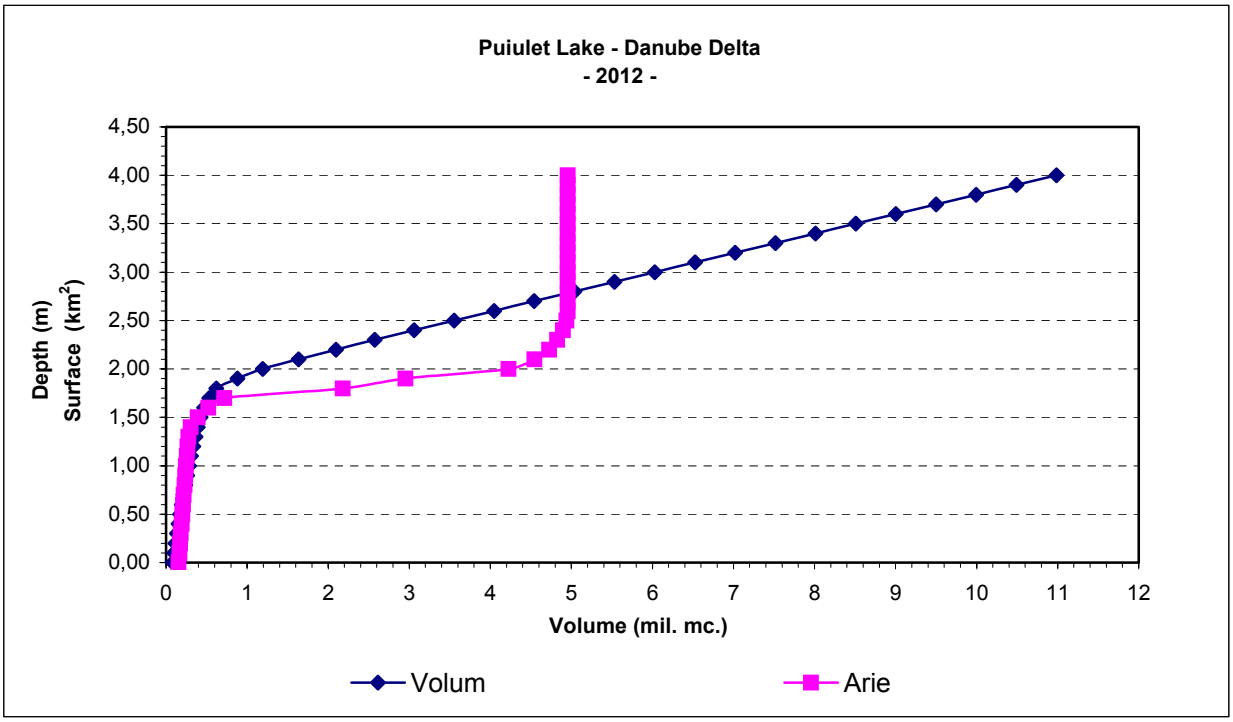


**Fig.2 The limnimetrical key of the Puiulet key**

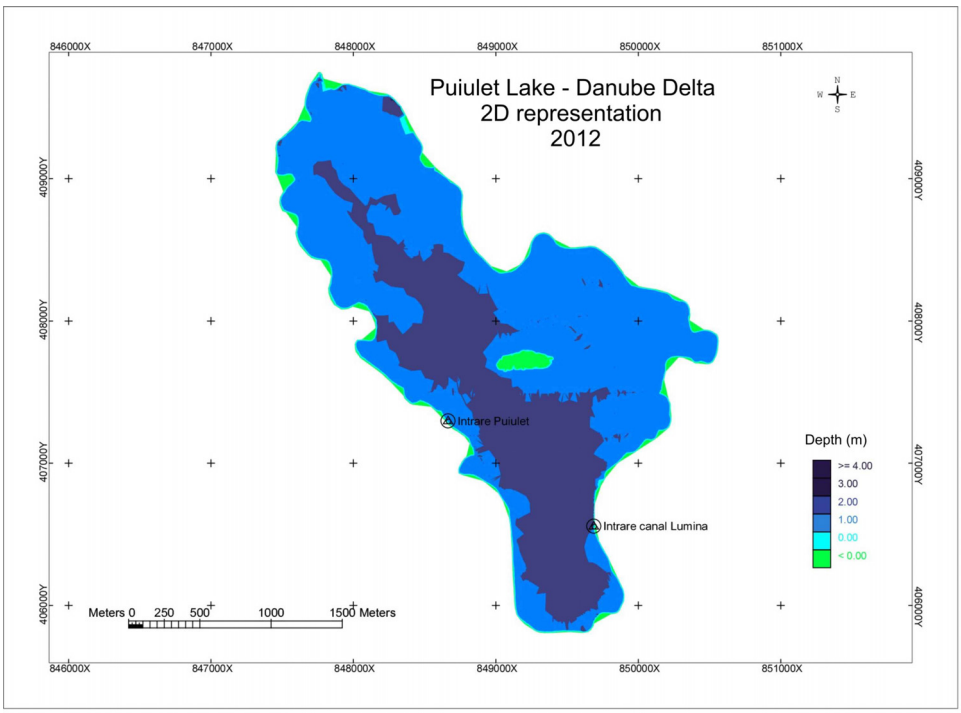


**Fig.3 2D representation of the Piulet lake**

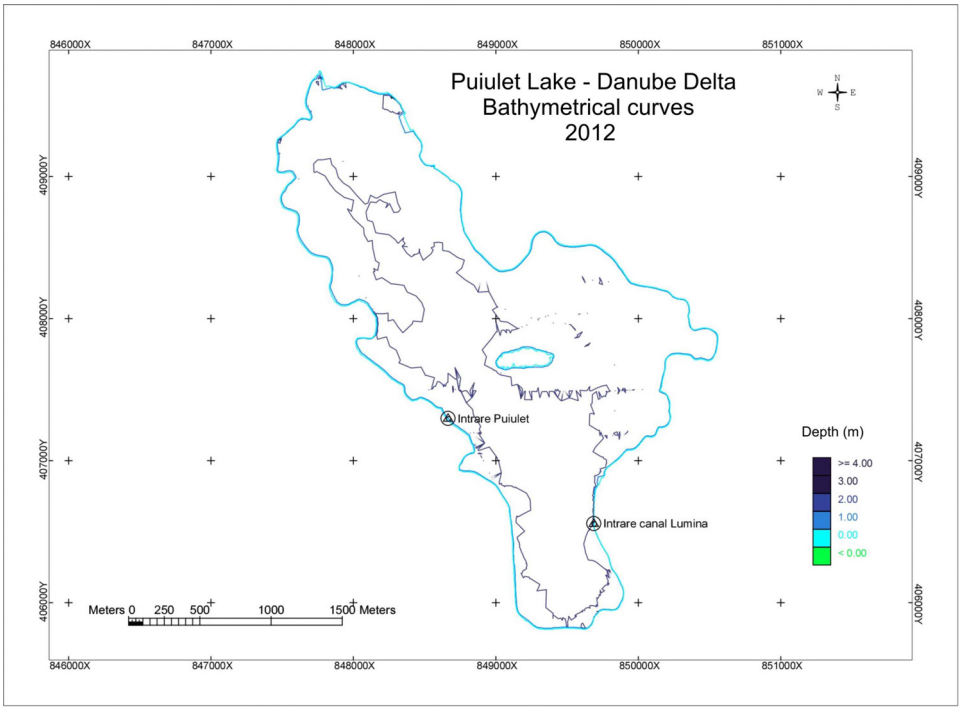


**Fig.4 Representation with bathymetrical curves of the Puiulet lake**

## 4. CONCLUSIONS

Attaining an evolution of the delta space is possible through the GIS technology which has been implemented in Romania at this point, starting from the previously measured data which can be digitalized and introduced in the desired electronical format.

The evolution of the Puiulet Lake is, at this point, obvious, the water surface being constantly growing. The relation resulted in the undergone analysis shows a liniar tendency of variation, which can be mathematically expressed trough the following equation: Surface (ha) = 3.9312x the year-7436.8.

The motivation of this tendency is quite difficult, but we can take into consideration the following:

- The flow capacity on the Sulina firth was permanently growing in the last tens of years (7.4%- 1857, 9.0%-1902, 12.0%-1921, 18-19.0%-1990 and approximately 20% in 2003);
- The decrease in the quantity of alluvium transported by the water after building in 1970 and 1983 the great dams Iron Gates I, respectively Iron Gates II but also the building of the dams on the inner rivers of Romania (fig.5);
- The decrease of the water surface covered with floating reed formations.

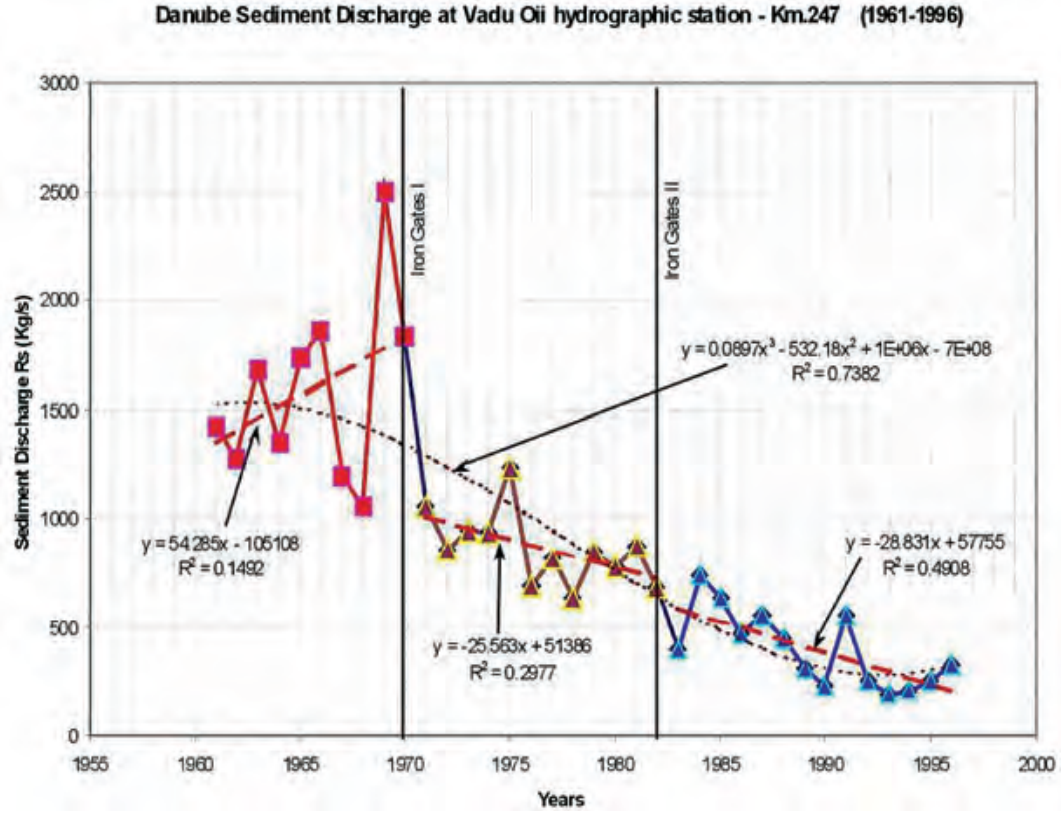


**Fig.5 The variation of alluvium quantity during 1961-1996, Vadu Oii-Dunare (Topo-Europe Summer School, Bucureşti-Constanta, N.Panin, pag.33)**

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