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A STATISTICAL ANALYSIS OF THE DANUBE FLOW REGIMES IN BRĂILA HARBOUR AREA

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ABSTRACT

It was in the frame of the „Restoration of the aquatic and terrestrial ecosystems complex, from Fundu Mare Island, part of the Small Wetland of Brăila - RAMSAR site 1074" project to look for solutions to improve the hydro schemes for lakes and related channels. These flow regimes are directly influenced by the flow regimes of the Danube arms surrounding the island. The main parameters of natural influence are Danube water levels and charge. The project proposes the construction of weirs which would improve water flow regimes in the island's channels connected with the Danube.
This paper shows how to optimize the construction of weirs on the basis of the analysis of the annual cyclic variation in the level of the Danube River.

KEYWORDS: water technology, Danube River, charge, reference level of the water

1.INTRODUCTION

The restoration of the aquatic and terrestrial ecosystems complex, from Fundu Mare Island, part of the Small Wetland of Brăila - RAMSAR site 1074 project is a necessity due to massive damming of the Danube River, in the 50's and 60's. After Ialomiţa Wetland and Great Brăila Wetland became polders, i.e. artificial hydrological entities, by damming and removing them from the floodable area of the Danube, thus the floodable area between Silistra and Brăila has being reduced to a tenth from its initial extension.

The phenomenon is complex because there are a number of influence factors:

- -Construction of dams on the Danube;
- -Construction of dams on tributaries of the Danube;
- -Interventions on navigation channel associated with river transport.

The research shows a significant deterioration in the relationship between sedimentation and erosion. Consequently, there have been changes in the morphology of the lake complex of the Small Wetland of Brăila.

It may be noted first a decrease in the water level, and this favoured next an invasion of allogenic vegetation. Both phenomena have after all a strong impact on the ecosystem.

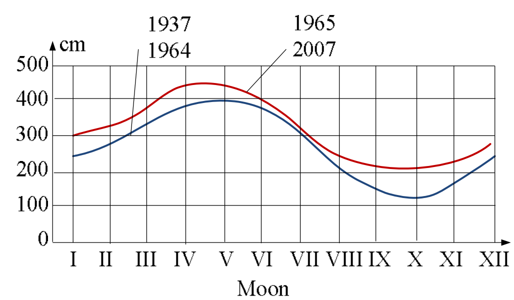

Fig. 1 Average monthly variation in the Danube level for 1937-1964 and 1965-2007 periods at Brăila hydrological station (i.e. before and after the damming) [1]

Currently, including this very ecological restoration project, solutions are being sought to correct the existing situation. To make the correct decisions, it is necessary to know the variation of the influence factors. We believe that the main influencing factor is the water level of the Danube River.

However, envisaged hydraulic works must

be done at a minimum scale, but able enough to produce the anticipated effects. Simultaneously, the activity of removing the allogeneic excess vegetation will be achieved.

The accomplishing of the restoration measures should take place under the following external conditions:

-Acceptable atmospheric conditions;

-The surfaces should allow the use of the conventional equipment.

This involves, among others, choosing the correct period of the year when one can work in optimal conditions, with reduced technical and economic efforts. Works will be initially run on Fundu Mare Island. Next, from the analysis of the immediate and medium-term results, we will get the necessary conclusions for spreading out this working model over the other wetlands, which now face the same problems.

2.BACKGROUND OF THE RESEARCH

The project, funded under the EEA Grants (European Economic Area), started in May 2015. Initially, the project was supposed to be completed in April 2016. This implies that the field work stages were supposed to occur in the winter of 2015-2016. Therefore there were a number of major inconveniences:

-Low temperatures;

-The possibility that the Danube to be frozen or with floes;

-High water level, the site of the dams (not yet known) being flooded;

-High probability that the excessive vegetation area, which was to be removed, will be under water or ice.

Making environmental restoration work in such conditions would be difficult because:

-Special materials would have been required, to be used under the conditions of cold and high humidity;

-Site organization is difficult in winter conditions;

-The transport of materials and equipment depends to a large extent on the condition of the Danube;

-Machinery should be able to work in shallow water, under heavy winter;

-The processing time of the materials increases significantly (strengthening concrete and drying paint, etc.);

-Soil condition can change from day to day, from ground to mud or it can freeze.

These technical difficulties have significant consequences in terms of:

-Cost of the works;

-The quality of work;

-Sustainability of the developments.

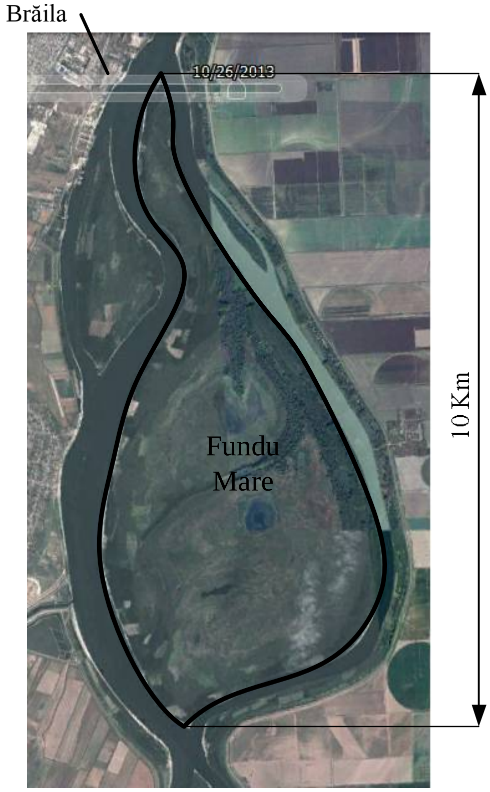

Fig. 2 Fundu Mare Island at 26.10.2013 (as downloaded from the Google Earth application)

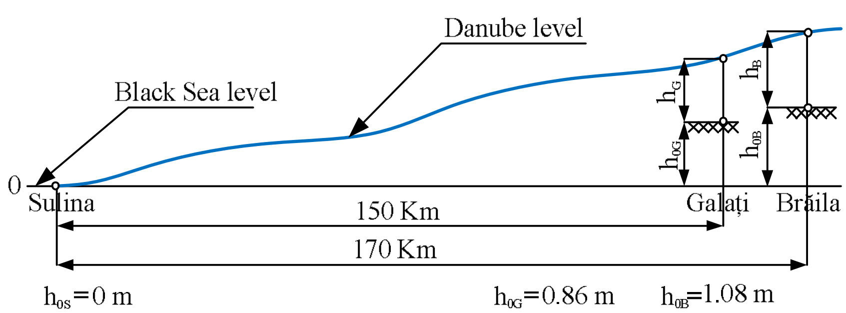

Fig. 3 Reference levels scheme on the maritime Danube.

Therefore, we discussed with the Program Operator (PO) to find alternative solutions attainable in less difficult conditions and also less expensive. In order to emphasize this idea we conducted a study of the Danube levels over a longer period. As there is no relevant data gathered or recorded for our specific area of interest, the Small Wetland of Braila, we have used the data recorded by the hydrological station Brăila [4].

This approximation is justified because:

- The northern part of the Fundu Mare Island starts right in front of Brăila city and extends towards south over about 10 Km (Figure 2);
- The hydraulic slope of the Danube River around Fundu Mare Island is J=1...5cm/km, according the daily level.

Danube levels are reported to elevation markers located in the harbour basin. The real level, based on the Black Sea level – Sulina harbour (level that is considered to remain constant) is determined by adding h_{0x} fixed differences (Figure 3).

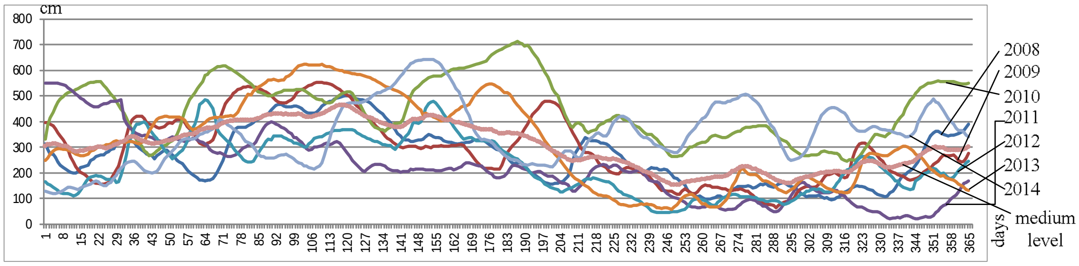

Fig. 4 Average daily variation in the Danube level (years 2008 – 2014)

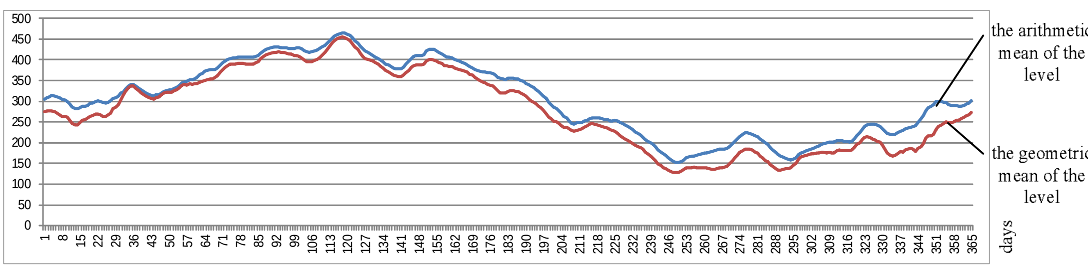

Fig. 5 Arithmetic and geometric mean variations in the Danube level (years 2008 – 2014)

3. DATA PROCESSING

To get a picture of how variation in the level of the Danube near the reference point was considered the primary source of information - National Administration „Romanian Waters" (NARW). From the data records information was extracted on the evolution of the level and flow of the Danube, in the Brăila harbour, for the period 2008-2014.

In order to obtain the relevant information from the NARW supplied data, a data „cleaning" process was previously made.

This data processing started with the removal of the data affected by non-acceptable errors. A person may record a wrong value, misread a scale, forget a digit when reading a scale or recording a measurement, or make a similar blunder. These blunders should not be included in the analysis of data. Also, some systematic errors were found and they were corrected in order to be kept in the data set.

Table 1 presents data on variation of the level of the Danube at Braila.

Table 1

year	08	09	10	11	12	13	14	Arith.	Geom.
days	h_i	h_i	h_i	h_i	h_i	h_i	h_i	h_{Ba}	h_{Bg}
	cm	cm	cm	cm	cm	cm	cm	cm	cm
1	314	395	333	552	164	250	128	305	275
2	292	395	386	551	157	259	125	309	277
3	274	390	414	551	153	273	122	311	277
4	273	385	438	551	145	287	120	314	277
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
364	377	257	548	161	240	136	347	295	267

365	389	277	550	169	246	132	341	301	272

To extract relevant information, the data have been processed mathematically.

In the analysis, the arithmetic mean calculated with equation (1) and the geometric mean calculated with equation (2) were determined for same day of the year all over the mentioned period.

$$h_{Ba} = \frac{\sum_{1}^{7} h_i}{7} \quad (1)$$

$$h_{Bg} = \sqrt[7]{\prod_{1}^{7} h_i} \quad (2)$$

Figure 4 shows graphically the annual change in the level of the Danube at Braila, over a whole year period.

The annual evolution of the arithmetic and geometric means of Danube level for the years 2008 - 2014, in Brăila is depicted in Figure 5.

4. CONCLUSIONS

From the analysis of the extracted data on the annual variation of the Danube level, summarized in Figures 1 and 5, the following can be observed:

-The maximum levels are recorded in March, April, May, June;

-Minimum levels are recorded in August, September and October.

Therefore, the project works should be conducted in a period characterized by a minimum level of the Danube, including partially or totally, August, September and October.

This period is optimal:

-Because it has minimal impact on bird colonies;

-In terms of thermal regime;

-In terms of rainfall regime.

In the aforementioned period, we will be able to use common equipment for dry soils and also the site organization would be easier.

The most important aspect is that the restoration works will be of a good quality. The expenses will also be reduced compared with the situation in which the works had been completed as initially planned, i.e. mostly during the winter period.

These conclusions were already presented to the Program Operator that has accepted a nine months extension for the period of project implementation in order to have a better and long-term solution for the ecological restoration.

ACKNOWLEDGMENTS

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