THE EFFECTS OF DAMMING ON THE ACQUATIC ENVIRONMENT. CASE STUDY: THE DANUBE, REGION CETATE – DĂBULENI

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Abstract. The Danube is the second longest river of Europe (after the Volga), being the only European river that flows from West to East. The lower sector of the river is between Iron Gates and its mouth, and has 1,072 km, which represents 38% of the river total length. Before entering the Romanian Plain, the Danube has a zone of cataracts, which is the final crossing of the Carpathian Mountains. The aquatic biodiversity of the Danube is closely monitored, and this paper attempts to show a community of species of phytoplankton and macro invertebrates, found in different regions of the river, on the sector Cetate-Dăbuleni.

Keywords: phytoplankton, macrozoobenthos, the Danube River, dimming.

Rezumat. Efectele îndiguirii asupra mediului acvatic. Studiu de caz: Fluviul Dunărea, sector Cetate-Dăbuleni. Dunărea este al doilea ca lungime între fluviile Europei (după Volga), fiind singurul fluviu european ce curge de la vest la est. Sectorul inferior al Dunării se desfăşoară între Porţile de Fier şi vărsare, pe o lungime de 1.072 km, ceea ce reprezintă 38% din lungimea totală a Dunării. Înainte de a intra în Câmpia Română, Dunărea străbate zona cataractelor care reprezintă străpungerea definitivă a arcului carpatic. Biodiversitatea acvatică a fluviului Dunărea este intens monitorizată, iar lucrarea prezentă îşi propune să expună comunităţi de specii din categoria fitoplancton şi macrozoobentos, determinate în diferite secţiuni ale fluviului, pe sectorul Cetate-Dăbuleni.

Cuvinte cheie: fitoplancton, macrozoobentos, fluviul Dunărea, îndiguire.

INTRODUCTION

Also known as the “Great Blue Diagonal” of Europe, the Danube drains the Pannonia and Pontic basins, surrounded by the Hercynian, Alpine, Carpathian and Balkan Mountains and crosses 11 countries in its way. The lower sector of the Danube is between Iron Gates and its mouth, having a length of 1,075 km, which represents 38% of the total length of the river (ARDELEAN et al., 1964; BREZEANU et al., 2011).

Integrating the researched area in the environment. The river, the second in terms of length in Europe after the Volga, forms a great part of the Romanian border with Serbia and Bulgaria. The Jiu river is a left tributary of its lower sector, keeping in mind that the water resources originating from rivers are of about 40^2 billion m³, which represents 20% of the water resource of the Danube River (ISSWaP Raport, 2010).

At the entrance in the Romanian Plain, the Danube valley is characterised by a gradual expansion and by the appearance of a floodplain developed on the left shore. The right shore is higher and looks like a chain of hills, the highest altitude being 200 m. Downstream the town Cetate, the left shore has a large floodplain, with numerous lakes, fens, deserted tributaries, having the role of regularizing the flow of the Danube during floods (POSEA et al., 1974).

The Danube represents the border of Dolj County and carries its flow on about 150 km, from the mouth of the Drincea to the isle Papadia, by Dăbuleni. The 180 degrees detours the river makes – between Cetate and Calafat, Calafat and Rast – the tendency to broaden and the wideness of the banks through the appearance of numerous isles (in comparison with the higher sector from Cetate) show that the river crosses a region the geological and evolutional features of which have led to a certain instability even in our times (BUDEANU & CĂLINESCU, 1982; BADEA D., 2012; CIOBOIU & BREZEANU, 2012).

Actually, it is known that after the river crosses a sector characterized by certain upward, downstream Calafat it enters a lowland area, influenced by a slow process of immersion. In these conditions, the river has many changes of direction and a significant decrease of the slope drain. If between Cetate and Calafat, influenced by the upstream height, the decrease is of about 0,070‰, between Calafat and Bistreţ it reduces to almost a half, the same as the average slope along the whole river, from Drobeta Turnu Severin to its mouth.

Having that slope means that, Dolj County, the river decreases with less than 7m. Such a small slope can only have as consequences the decreasing of the flow rate, of the transport capacity and of slit deposition, smaller riverbed, tendency of wideness of the bank and a higher number of isles (BANDRABUR et al., 1963; BADEA & GHENOVICI, 1974; COTEŢ, 1957; CIOBOIU, 2003).

The main dams in the area Cetate- Dăbuleni. The left bank of the Danube has, beginning with the area limited by the dam Porţile de Fier II, dammed areas, their main role being that of defense in case of floods. (Fig.1, Table 1).

Table 1. Length of the main dykes of the Danube (left bank, Dolj County).

Polder	Length of the dyke (m)
Ghidici-Rast-Bistret	22,700
Bistret-Nedeia-Jiu	39,130
Jiu-Bechet	25,000

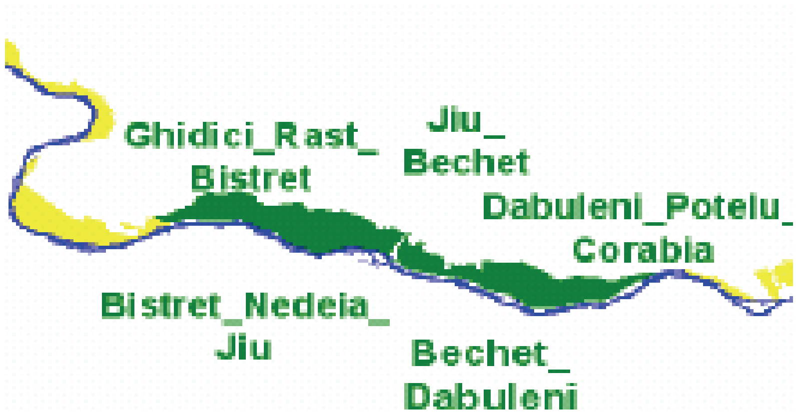

Figure 1. Dykes and polders on the Romanian Sector of the Danube (after Jiu River Management Plan, 2009 Rapport).

The flows of the Danube River. At Cetate, the annual average flow of the Danube is of about 5,450 m^3/s, and at Bechet of more than 5,570 m^3/s. The surplus registered in Dolj is due mainly to the Jiu river (with a flow of about 90 m^3/s), the most important tributary of the Danube at its entrance on the territory of Romania (DIACONU & LĂZĂRESCU, 1965; COTEŢ, 1973; ŞERBAN et al., 1989).

Based on these average multiannual values, we must take into consideration that the volume of waters collected by the Danube has very high variations. While the maximum flow is, in exceptional situations, close to 15,100 m^3/s (in April 1940 and 1942, at the hydrometric station Orşova), the minimum was far below 2,000 m^3/s, for example in 1946, 1947 or 2003 (1,492 m^3/s at the hydrometric station Drobeta Turnu Severin).

The maximum flows usually appear in the spring months and at the beginning of summer – April, May, June- when it is known that the usual floods occur on the Danube, and a third of the annual volume of water flows. In late summer and especially in the autumn months – September, October – the maximum flows are registered, followed by a new increase of waters caused by autumn rains. In January – February, we have the second minimum that is a period of reduced flow because of the frost (GÂŞTESCU, 2000; IONESCU, 2001; SAVIN, 2004).

The Danube freezes in cold winters. Even if the ice floes can appear on the banks in the beginning of December, upstream of the Olt mouth, an ice bridge forms the earliest only in the first part of January. The period in which the ice floes appear and remain on the river can expand until the half of March, but the longest period in which the Danube was frozen did not cumulate 2 months (Bechet, 54 days, 1953-1954).

MATERIAL AND METHOD

The **material** used in this research is represented by samples collected for physic-chemical and biological determinations, respecting the technique of sampling and analysing according to the regulations in force. The analysis has been made in the specialized laboratories of the University of Craiova. The biomarkers, samples and taxonomic determinations were made on groups of indicators (macro invertebrates and phytoplankton). The species have been identified using taxonomic determinations, used also at the national level.

The **method** used for evaluating the anthropogenic impact using the biological parameters is represented by the method of the *saprobe index method (S)*. In order to sample and determine the physic-chemical parameters, there were used some results obtained by respecting the working procedures implemented in the laboratories specialized in analysing water and sediments (NAUM & GRIGORE, 1974; GIURMA, 1997).

RESULTS AND DISCUSSIONS

The Danube river in Calafat section for phytoplankton biological parameter has an saprobe index s=1.84, respectively a saprobe index s=1.96 for macrozoobenthos. In phytoplankton area, there are identified the next species: Bacillariophyceae (*Pinnularia viridis*, *Cymbella lanceolata*, *C. ventricosa*, *Stauroneis phoenicenteron*, *Navicula gracilis*, *Nitzschia sigmoidea*, *Synedra acus*, *Diatoma vulgare*, *Caloneis amphisbaena*, *Surirella biseriata*, *Tabellaria floculosa*, *Fragillaria crotonensis*, *Gyrosigma acuminatum*), Chlorophyceae (*Cosmarium formulosum*, *Ulothrix zonata*, *Ulothrix tenerima*, *Spirogyra porticalis*, *Scenedesmus quadricauda*, *Chlorella vulgaris*, *Zygnema stellinum*), Cyanobacteria (*Oscillatoria subtilissima*, *Microcystis aeruginosa*). Euglenophyta group was represented by the *Trachelomonas rugulosa*.

For the Danube zooplankton, there were identified 200; the most frequent species are: *Charchesium rachmanni*, *Tokophrya cyclopum*, *Diflugia acuminata*, *D. oblonga* (protozoa); *Brachionus calyciflorus*, *Keratella quadrata*, *K. cochlearis*, *Asplanchna priodonta*, *Polyarthra vulgaris*, *Filinia longiseta*, *Brachionus leydigi*, *Notiluca striata* (rotifers); *Cyclops leukarti*, *Diaptomus* sp., *Acanthocyclops serrulatus*, *Mesocyclops crassus*, *Eucyclops* *serrulatus*, *Microcyclops varicans* (copepods); *Daphnia longispina*, *D. hyalina*, *D. cuculata*, *Moina micrura*, *Bosmina longirostris*, *Sida cristalina*, *Alona* sp., *Chydorus* sp. (cladocera), *Paramaecium bursaria* (Ciliata group).

Scientific biocoenotic types: *lithorheophilic*, *clay-rheophilic, psammorheophilic, pelorheophilic*. In case of macrozoobenthos, there were identified the following species: *Hypania invalida*, *Nais communis*, *N. simple*, *Stylaria lacustris*, *Paranois frici*, *P. simplex*, *Uncinais uncinata*, *Lymnodrilus hoffmeisteri*, *Tubifex tubifex*, *Peloscolex ferox, Lumbriculus variegatus* (worms); *Physsella acuta, Lymnaea stagnalis*, *Radix balthica*, *Planorbarius corneus*, *Gyraulus albus*, *Theodoxus fluviatilis*, *Th. danubialis*, *Viviparus acerosus*, *Valvata piscinalis*, *Lithoglyphus naticoides*, *Esperiana esperi*, *E.* (*Microcolpia*) *acicularis* (gastropods); *Dreissena polymorpha*, *Unio pictorum*, *Anodonta piscinalis*, *Sphaerium riviculum*, *Sph. corneum* (bivalve); *Chaetogammarus tenellus*, *Stenogammarus similis*, *Dikerogammarus fluviatilis*, *Pontogammarus sarsi*, *Corophium curvispinum*, *C. moeoticum*, *Astacus fluviatilis* (crustaceans); *Palingenia longicauda*, *Heptogenia sulphurea*, *Baetis tricolor*, *B. bioculatus*, *Caenis robusta* (ephemeroptera); *Ghomphus flavipes* (odonata); *Hydropsyche ornatula*, *Neureclipsis bimaculata*, *Psychomyia pusilla*, *Rhyacophila mubila*, *Setodes punctata*, *Ecnomus tenellus* (trichoptera); *Tanytarsus lauterborni*, *T. exiguus*, *Cryptochironomus defectus*, *C. vulneratus*, *Tendipes plumosus, T. thummi, T. semireductus, Polypedillum convictum*, *Paratendipes connectens, Glyptotendipes* sp., *Rheotanytarsus* sp., *Eukiefferiella longipes*, *Cricotopus* sp., *Diamesa compestris*, *Procladius* sp. (chironomids). The frequent species are: *Tubifex tubifex* of Oligochaeta, *Gammarus fossarum*, *Astracus leptodactyllus*, *Dikerogammarus bispinosus* (crustacea group) (BREZEANU & GRUIŢĂ, 2002; CIOBOIU, 2006; 2010; BADEA D., 2012).

The Danube at Bechet has a saprobe index s=2.01, representing plankton, and the benthos has a saprobic index s=1.9, which shows a moderately contaminated water, framing the sector in the area β- saprobe, 2nd class of quality. The representative species belong to the branch of Bacillariophyta (*Asterionella gracilima*, *Cymatopleura solea*, *Navicula gracilis*, *Synedra acus*, *Hantzschia amphioxus*, *Amphipleura pellucida*, *Cymbella lanceolata*, *Cymbella ventricosa*, *Caloneis amphisbaena*, *Cocconeis placentula*, *Pinnularia viridis*), Chlorophyta *(Spirogyra porticalis, Scenedesmus quadricauda, Ulothrix tenuissima, Chlorhormidium rivulare, Chlorella vulgaris*), Cyanophyta (*Aphanisomenon flos-aquae, Croococcus turgidus*), Ciliata (*Paramaecium bursaria*). The macrozoobenthos is represented by few species, such as: Odonata (*Gomphus sp.*), Heteroptera (*Napa rubra*), Mollusca (*Viviparus sp., Gyraulus albus, Lithoglyphus apertus, Litoglyphus pygmaeus, Theodoxus sp.),* Crustaceans (*Gammarus phossarum, Dikerogammarus bispinosus*,), and Oligochaetae (*Tubifex tubifex*).

CONCLUSIONS

The obtained results are correspondent for the β- saprobe area, the 2nd class of quality, (moderately contaminated water), or a good environmental state, according to DCA60/2000/CE (GAVA et al., 2007). These results are generally correspondent to the ecological state of the Danube on other similar sectors, which is why we could say that the research led to the conclusion that damming does not affect the quality of the water of the Danube, but has an impact on the hydro morphology of the river, influencing the flow rate, width and depth of the water.

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Received: March 31, 2014
Accepted: July 22, 2014