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Water quality of the Dniester river right tributaries depending on the pollution sources

Maria Sandu, Anatol Tariţă, Elena Moşanu, and Raisa Lozan

Abstract. According to the water quality Index calculated in different sections of the Dniester River tributaries the water was from medium pollution to polluted state, in Botna river (Căuşeni town) in 1995 and 2004 being very polluted. The water in Răut river in 2015 was of average pollution, at Balti town being polluted. A detailed study was carried out for the water from Bâc river, Chisinau municipality, in 2009, through the calculated ICAcc, it was demonstrated that the water entering the territory of Chisinau municipality was already polluted, reaching very polluted downstream of the sewage treatment plant from the municipality.

Keywords: water, quality Index, tributaries, Dniester river, sources of pollution.

Calitatea apei din afluenții din dreapta râului Nistru în funcție de sursele de poluare

Rezumat. Conform indicelui de calitate a apei calculate în diferite secțiuni ale afluenților râului Nistru, apa era de la o poluare medie la o stare poluată, în râul Botna (orașul Căușeni) în anii 1995 și 2004 apa era foarte poluată. A fost efectuat un studiu detaliat pentru apa din râul Bâc, municipiul Chișinău. În anul 2009, prin calculul ICAcc, s-a demonstrat că apa care intră pe teritoriul municipiului Chișinău era deja poluată, ajungând foarte poluată în avalul de epurare din municipiu.

Cuvinte-cheie: apă, Indexul calității, afluenți, râul Nistru, surse de poluare.

1. Introduction

The hydrographic network of the Dniester river basin is represented by 1591 rivers, which also have territories adjacent to natural areas protected by the state, represented by all the variety of categories of protected areas. Among the most significant protected areas in the basin are the natural reserves Codru (5177 ha), Iagorlîc (836 ha), Plaiul Fagului (5642 ha) and Orhei National Park (33 792.09 ha) [1]. The longest tributaries in the Dniester river basin are the Răut, Bâc and Botna rivers.

The influence of the anthropogenic factor and the caused pollution change the composition of the water, affect the fauna and flora in the aquatic environment. The sources of

surface water pollution in the Republic are insufficiently purified or untreated wastewater discharges from the domestic and industrial sectors, meteoric water discharges, from various waste deposits, from agricultural fields, domestic livestock, etc.

The existence of pollution sources from recent years is mentioned in the Yearbook of the Inspectorate for Environmental Protection - 2020 [2]. The main activities and urban agglomerations that cause water pollution are: industry (activities in the energy field, sugar/alcohol/bakery industry, etc.), urban agglomerations with the most numerous household waste deposits, agriculture and animal husbandry.

In 2020, in the Dniester river basin there were 154 waste water discharge and treatment complexes, only 20 units (13%) were with standard treatment, and 74 (48%) systems were with insufficient treatment, 19 (13%) with partial treatment and 41 (26%) treatment stations were not working. Most systems (14 units) did not work in Donduşeni district, 5 stations in Teleneşti district, 4 units each in Rezina and Străşeni districts, and in other districts 1-2 wastewater treatment systems did not work. Annually in the hydrographic network of the Dniester basin, on average, are discharged 1212.6 thousand m3 of waste water, of this volume only 13% is sufficiently purified [1].

Another point source of pollution is waste dumps. In the Republic of Moldova the disposal of municipal waste at the moment is mainly carried out by storing it on the ground. According to the data of the Environmental Protection Inspectorate [2] in 2020 in the districts of the Dniester river basin there were 619 waste depots in operation, organized practically in every locality by the local public authorities. In the protection zone of water bodies, 66 municipal waste deposits were located, which represent a source of water pollution. At the same time, 150 waste deposits were located at a distance of less than 500 m from the housing sector, especially in the rural sector, which endanger the health of the population and the quality of local surface and underground waters.

Some of the diffuse pollution sources are agricultural land, which in the Dniester river basin occupies 76,53% of the total area, and atmospheric deposition, involving in the process of discharge wastewater, wastes, chemical fertilizers, pesticides, etc. [1]. Thus, studies on the quality of surface waters have an important role because in the Republic they are exposed to pollution.

In order to reflect the influence of different parameters on water quality, transforming large amounts of data into a single number, have been developed different water quality indices, which have a value of the water quality level. A synthesis of surface water quality indices was made by Couillard D., et al (1985) [3] to transform water quality data into a unique format.

The purpose of the present study is to evaluate the ecological state of the water in the right tributaries Răut, Bâc, Botna and Ichel of the Dniester River using the calculated Water Quality Index.

2. Materials and methods

A water quality index is a tool for transmitting information to the general public, water users, scientific researchers, managers, parliamentarians, engineers, etc.

In the assessment of the surface water quality index (ICAcc,%), which is applied to assess water quality according to the requirements specified in Government Decision no. 890 of 12.11.2013 [4], was used the national standard SM 354: 2021 [5].

The surface water quality index includes a scale of 100% based on quality classes (I-V) according to the concentration of substances specified in the Regulation on environmental quality requirements for surface water [4].

The general classification of surface water quality was proposed according to the US National Sanitation Foundation's scoreboard, mentioned in table 1 [6, 7].

Table 1. Legend of the Surface Water Quality Index

IPAcc, %	State	Quality class
90-100	Excellent	I
70-90	Good	II
50-70	Medium pollution	III
25-50	Polluted	IV
0-25	Very polluted	V

In the present study the ICAcc is evaluated in the water of the right tributaries of the Dniester river in different years (1995-2015), using in the calculation the information from scientific publications [8-13], resulting from the hardness and mineralization of the water, the concentration of NH_4^+, NO_2^-, NO_3^-, Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, SO_4^{2-} ions, of the pH, CBO_5 and $CCO - Cr$ values.

3. Results and Discussion

The study shows that the water quality of the Dniester River tributaries in the years 1995-2015 was from medium pollution to the polluted state (Fig. 1):

- ICAcc in the Bâc river water varied from 42% (polluted) to 63
- The water in the Botna river had ICAcc from 31%-36% at Căuşeni city (polluted), to 66% (medium pollution).

- In the Răut river in 2015 the water was as medium polluted (Floresti - Orhei town, ICAcc 62-65%) and in the years 1995-2009 it was polluted in all sections (ICAcc 42%-58%).
- In Ichel river (Paşcani village) ICAcc was within the limits of 46%-58% (polluted).

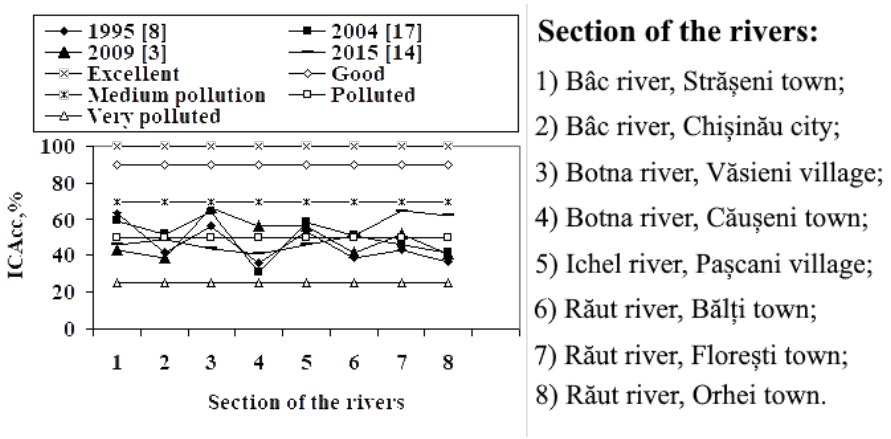

Figure 1. Dynamics of the water quality index in the rivers Răut, Bâc, Botna and Ichel.

A detailed study was carried out for the water in the Bâc river, Chişinău municipality, in the local environmental action plan of Chişinău municipality, year 2009 [11]. Through the water quality index, calculated on the basis of the physical-chemical composition of the water in the text of the Plan, it is specified that the water from the Bâc river at the entrance to the territory of the municipality was already polluted (ICAcc, 53%), reaching a low index of 31% quality (highly polluted) downstream of the municipal wastewater treatment plant (SEB) (Fig. 2).

ICAcc (%) of the tributaries water when it flows into the Dniester river, calculated based on the information from the publication of Viorica Gladchi, etc (2013) [12], based on the annual average from the years 2009-2010, is higher for the water from the Răut river (65%), which corresponds to the medium pollution category. In the Ichel (58%) and Botna (55,5%) rivers, the water at the discharge into the Dniester river was polluted, being very polluted in the Bâc river (46%) (Fig. 3).

Based on the fact that insufficiently treated waste water is discharged into the hydrographic network of the Dniester river basin or, in general, some wastewater treatment systems do not work, in order to improve the quality of natural waters, it is necessary to

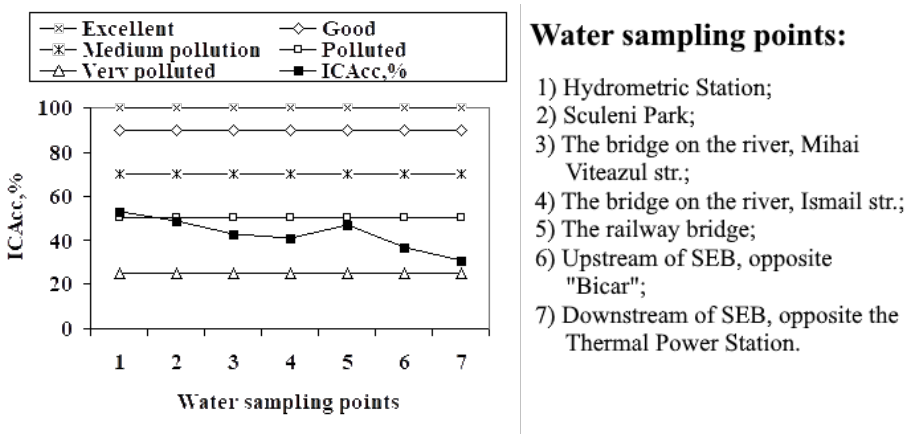

Figure 2. Dynamics of the water quality index in the Bâc river, Chişinău city, year 2009.

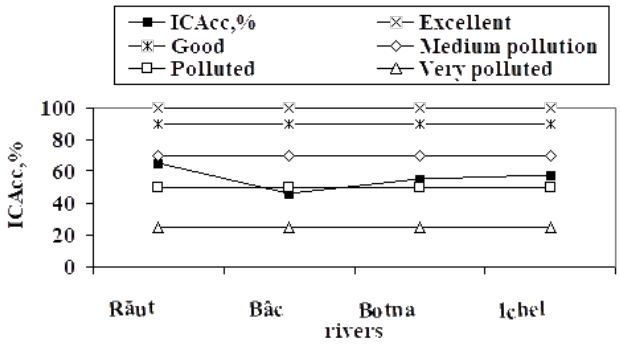

Figure 3. The water quality index of the Răut, Bâc, Botna and Ichel rivers on them flow into the Dniester river (years 2009-2010).

implement efficient domestic and industrial from all fields of activity wastewater treatment stations, through which the normative requirements of Government Decision no. 950 of 25.11.2013 [14] will be respected.

In order to intensify measures to protect and reduce pollution of aquatic resources, the Republic of Moldova has signed various conventions, including the Convention on the Use and Protection of Transboundary Watercourses and Lakes (Helsinki, 1992), the Danube Convention (Sofia, 1994) and the Convention on the wetlands important for wading birds (Ramsar, 1971). In order to comply with the Convention on the use and protection of watercourses, the forested areas and riparian strips of water protection have an important role for the ecological state of the environmental components in the Dniester river basin [14].

The total national forest fund is of 419,1 thousand ha with an area covered by forests of 374,5 thousand ha. In the river basin, forested areas constitute 11,07% of the territory, the average for the country being 10,4% [15]. The largest forest bodies are in the districts of Străşeni – 35,8%, Călăraşi – 30,1% and Orhei – 19,4% and Şoldăneşti – 18,8%, many of them being included in the natural areas protected by the state [16].

The area and forested share of the sub-basins, which are part of the Dniester river basin, are: the Bâc river basin is covered with 45,797 ha of forests (20,69%), followed by the Ichel river basin with 17,782 ha (20,26 %), of the Botna river with 26155 ha (15,39%) and of the Răut river with 57597 ha (7,4%) [1]. The need to ensure river water protection through protection zones and strips is specified in Law no. 440 of 27.04.1995 [17]. In article 4 of the law it is mentioned that in the water protection zone the riparian strip is separated within the boundaries of which the economic activity is strictly limited. The dimensions of the water protection zones of rivers and water basins (article 6) are established with a width of at least 500 meters from the edge of the river bed slope on the banks, but not further from the water table, and those of the river protection strips of waters (article 7) depend on the length of the rivers: streams and small rivers of at least 20 meters, medium rivers of at least 50 meters and for large rivers of at least 100 meters.

In order to minimize or prevent the pollution of the aquatic environment in the Republic by pollutants from waste dumps, it is necessary to use efficient waste management in compliance with the requirements of Law no. 1347 of 09.10.1997 [18], where are the requirements regarding the storage (burial) and preservation of waste (article 18), the manner of storage (burial) and preservation of waste (article 19) and restrictions (article 20). In article 20, point a, of the law it is prohibited to throw waste into drainage systems and aquatic objects, their storage and processing on the territory of the protection zones of basins and watercourses, in the sanitary protection zones of water supply sources drinking water and aqueducts, in recreation areas, nature reserves and parks, as well as in the protection strips of railways and roads. Only by complying with the conditions of the national legislation will the prevention or minimization of the level of pollution of the waters of the tributaries of the Dniester river be ensured, being proven to be a pollution over a long period.

4. Conclusions

- The water quality of the right tributaries of the Dniester river in all the years of study (1995-2015) was from medium pollution to the highly polluted state.
- ICAcc (%) of the water of the tributaries when it flows into the Dniester river, based on the annual average from 2009-2010, is higher for the water from the

Răut river (65%), being of medium pollution, and in the Ichel rivers (58%) and Botna (55.5%) the water was polluted, being the most polluted in the Bâc river (46%).

- In order to improve the water quality of small rivers, it is necessary to use efficient wastewater treatment plants for domestic and economic activities in order to comply with the requirements of the legislation on discharge into the environment.
- In the minimization and prevention of the pollution of the aquatic environment in the Republic by pollutants from household waste deposits and from all areas of economic activity, it is necessary to use an efficient waste management according to the requirements of the national legislation in force.

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(Maria Sandu, Anatol Tariţă, Elena Moşanu, Raisa Lozan) Institute of Ecology and Geography of the Moldova State University