

## THE SOCIO-ECONOMIC IMPACTS ON WATER RESOURCES IN THE RĂUT RIVER BASIN

Bacal Petru<sup>1</sup>, Ciocan Nadejda<sup>1</sup>, Vîrlan Daniela<sup>1</sup>

**Key words:** wastewater, discharge, river basin, Raut, treatment.

**Abstract.** The purpose of this research consists in the elucidation of spatial and economic aspects of the water use in the Răut river basin. The main topics presented in this paper are: 1) the dynamics of volume of wastewater discharged into the river Raut basin and its sections; 2) wastewater discharge by the degree of treatment; 3) spatial and branch profile of wastewater discharged; 4) existing problems in evaluation and monitoring of waste water. To achieve these objectives were used traditional methods of geographical and economic research.

### Introduction

Răut river is the right tributary of the Dniester River and is the longest river (286 km) that is wholly in the Republic of Moldova (figure 1). Raut River basin has an area of 7760 km<sup>2</sup>, about 23% from country area. In the Raut river basin are located Balti city and 7 middle urban and industrial centers, including Orhei, Drochia, Florești, Sângerei, Telenești, Dondușeni and Rascani. Thus,

Along the time, changes exercised by people on the environment, through completed economic activities, affects the quality of water resources from Raut river basin. In addition, insufficient presentation of statistical data in the region represent one of the most principal impediment of development and implementation, in the future, the projects focused on socio-economic sustainable development of human settlements activities.

A lot of farms do not use sewage disposal systems. In most cases the discharge of insufficiently treated and untreated water was provided by the livestock breeding complexes, many of which are located in the water conservation areas around the river. The discharge of the untreated municipal wastes remains a

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<sup>1</sup> Institute of Ecology and Geography, Academy of Economic Science of Moldova, p\_bacal@yahoo.com

topical issue. In some cases, water pipelines are built without construction of sewage facilities and sewage treatment plants. In addition, most rural households are not connected to centralized sewerage and effluents are not evaluated.

### **1. Theory and methodology:**

The present research is based on recent analytical studies on the implementation of the Management Plan of River Basin, which is stipulated in EU Directive (2000/60 / EC) on integrated water management [6]. For the study, the author has focused on management plans, which are being implemented, such as the Danube River Basin Management Plan [4], Management Plan of River Space Prut-Bârlad [8], Management Plan of Prut River basin [3]. Very valuable, in particular for determining the status and economic analysis of water use are research methodology and study transboundary rivers in the Black Sea Region and Belarus (EPIRB Program) [5].

The main methods, which are used in this study are: statistical, analytical, comparative, analogical, as well as consultation with competent authorities in the field of assessing and managing of water resources. Statistical method was widely used in processing of statistical information on the capture and use of water in all administrative-territorial units from the Raut river basin. The analytical method was used for: a) to identify qualitative aspects of sanitation system; b) diagnosis of situation in this space; c) establishment of problematic situations in regulating system; c) elaboration of recommendations to prevent problematic. The comparative method was applied for establishing the trends in the branch and spatial aspects of the use of water resources, the dynamics of tariffs for sanitation services.

The main informational and statistical support that formed the basis of this study included: 1) Generalized Annual Reports on Water Management Indicators elaborated by the Basins Department of Agency „Apele Moldovei” [9]; 2) Annual Reports of Ecological Agencies and Inspection [10]; 4) The Reports of water supply and sewage companies [7]; 5) analytical studies in this field [9], including of author of this article [2;3]. The study comprised mostly 2007-2015 years.



Figure 1. The map of Raut river basin

## 2. Results and discussions:

In analysed period (2007-2015), in the Prut river basin were discharged, on average, 8,0 million m<sup>3</sup> of wastewater, including 9 million in the Raut riverbed (table 1). which represent 1,6% of the country total discharged waste water (Table 1) and 14% on the Dniester right bank. Thus, in this basin were discharged 1,6% of the total volume of

Table 1. Discharged wastewater volume and weight per river basins, in million m<sup>3</sup> (average on 2007-2015)

River Basins	Total		Total	In natural water receivers							
	mil. m <sup>3</sup>	%	mil. m <sup>3</sup>	Without treatment		Insufficiently treated		Conventionally pure		Sufficiently treated	
				mil.m <sup>3</sup>	%	mil. m <sup>3</sup>	%	mil. m <sup>3</sup>	%	mil. m <sup>3</sup>	%
Răut	11,0	1,6/ 14 <sup>2</sup>	9,6	0	0	1,4	12	0,06	0,8	8,0	73
Răut river bed	9,1	1,3/ 12	9,0	0	0	1,0	11	0,06	0,6	7,7	85
Nistru	674	98	669	0,88	0,1	6,4	1,0	547	81	115	17
Totally, RM	683	10 0	677	1,0	0,15	8,8	1,3	551	81	115	17
Right bank of Dniester river	79	12	75,2	0,98	1,3	5,8	7,3	5,5	7,0	61,5	78

**Source:** elaborated by the author after data from *Generalized Annual Reports (2007-2015) on the Indices of Water Management in Moldova*. Bazine Department of the Agency "Apele Moldovei" [9].

<sup>2</sup> In the right bank of the Dniester river

wastewater discharged overall in the Republic of Moldova and 14% of the total volume of wastewater discharged into right bank of Dniester. At the same time, the share of this river basin of total volume of insufficiently purified waters is much more and constitute 16% and respective - 23%.

The largest volume of wastewater is discharged from Balti, which constitutes, on average 8,0 million m<sup>3</sup>, and in 2015 – 9,4 million m<sup>3</sup> or about 80% of the total volume of water discharged and 50% of insufficiently purified water discharged in this river basin. Also in 2015, large volumes of wastewater were discharged in Orhei (1,0 million m<sup>3</sup>), Drochia (620 thousand m<sup>3</sup>) and Florești (460 thousand m<sup>3</sup>). Minimum volumes of wastewater were discharged in the districts with smaller urban centers such as Telenești (190 thousand m<sup>3</sup>) and Donduseni (180 thousand m<sup>3</sup>).

In the last 25 years (1991-2015), the total volume of discharged wastewater in the Prut river basin decreased about times, from 97 million m<sup>3</sup> to 12 million m<sup>3</sup> [10]. The main causes are: drastic reducing of the volume of industrial and agricultural production and services; deplorable status and stopping the operation of several sewage treatment plants in the household sector, industry and services; partial presentation of data about wastewater discharge; superficial environmental control; negligence massive of environmental requirements by polluters etc.

Since 2007 it is found a slow increase trend and the average is 11 million m<sup>3</sup> (fig. 1). Increasing of the volume of discharged wastewater, overall in the Raut river basin, is due, primarily, to significant increase of the volume of wastewater discharge into the Upper Course (+ 42%) and into the Middle Course (+ 21%) of this river basin, especially from Balti city (+23%). In the Lower Course it is recorded a insignificant reduction (-3%), which is conditioned by similar reduction of wastewater volume discharged into the perimeter of Orhei district [9].

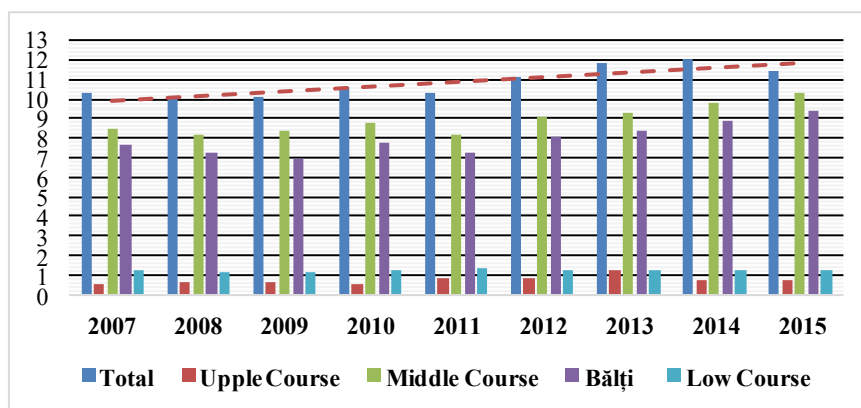


Figure 2. Dynamics of volume of wastewater discharges, in million m<sup>3</sup> [9]

In the natural waters pools are discharged, on average, 9,7 million m<sup>3</sup> (88%) of waste water, inclusively 9,0 million m<sup>3</sup> in the Răut river bed. In the retention basins were evacuated 1,4 million m<sup>3</sup>. About  $\frac{3}{4}$  (8,0 million m<sup>3</sup>) of discharged waste water are purified sufficiently and in the Răut river bed – 85% (7,7 million m<sup>3</sup>), which is exclusively due to Balti City. About 12% (1,4 million m<sup>3</sup>) are insufficiently purified waste water. The sewage discharged without treatment and conventional pure wastewater are almost missing.

At the same time, according to the ecologic reports [10], these data do not correspond to reality. More than this, most treatment plants are worn and damaged, and some do not work. Also, reports of the Agency "Apele Moldovei" contain inaccurate information (in million m<sup>3</sup>), which may not be subject to appropriate spatial or branch review, and in many districts the use and disposal of sewage include only data from the urban areas served by the municipal enterprises of the Association "Apă-Canal" [7].

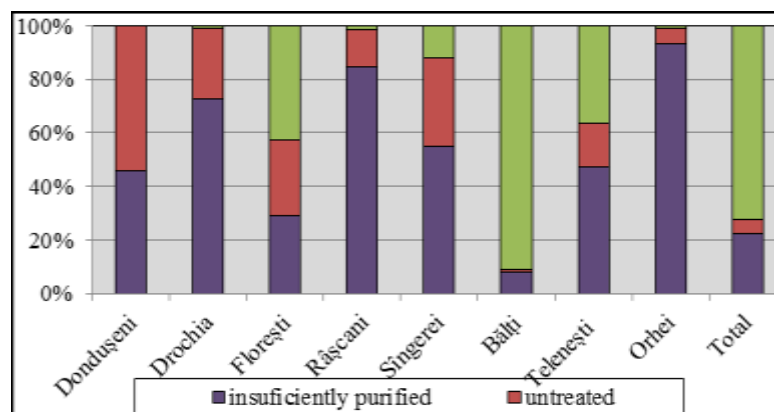


Figure 3 The purification level of wastewater discharged into Raut river basin [10]

According to local environmental authorities' annual reports for the years 2007-2015, about 75% of discharged waste water was sufficiently treated, and 20% are insufficiently treated, and 5% are untreated wastewater, which is much closer to reality than the data provided by the Agency "Apele Moldovei". The volume of discharged wastewater indicated in the regional environmental authorities' reports constitutes about 70% of that indicated in the reports of the Agency "Apele Moldovei" and includes only a part of the agricultural enterprises, which are attributed to pure conventional category. In addition, the environmental reports in some districts include a larger number of public utility enterprises. It is necessary to mention that general situation is conditioned exclusively by situation in the

Balti city, which discharge about  $\frac{3}{4}$  of total wastewater from Raut river basin. In the outside of Balti, most of wastewater discharged are insufficiently treated or untreated (fig. 3). In all districts of the Raut river basin share of insufficiently treated and untreated wastewater is 60-70%. An alarming situation is observed Donduşeni, Drochia and Floreşti.

Within the Răut river basin work 37 centralized waste water discharge systems or 6 times less than the water supply systems (Fig. 3, table 2). The maximum number of sewerage systems are found in the districts of Floreşti (12) and Orhei (5) and the absolute majority of rural localities do not have the centralized sewerage and wastewater treatment systems. Total length of sewerage network is 450 km, including 306 km or about  $\frac{2}{3}$  of companies members of Association "Moldova Apă-Canal". Length of sewerage networks is conditioned by the size of the served urban centers. Thus, the maximum length is registered in the Balti city (152 km), and in the districts Orhei (72 km), Drochia (53 km) and Floreşti (51 km). The minimum length (<30 km) is found in the Telenesti and Râşcani districts.

Unlike water supply systems, the sewerage and treatment systems do not register high growth rates (Fig. 4). Overall, according to the National Bureau of Statistics, the number and length of sewerage networks in the years 2007-2014 registred a negative trend, which is due to situation from Râşcani, Drochia and Orhei districts. Moreover, the coverage of water supply and sewerage networks decreased during the period by  $\approx 2$  times (from 29% to 16% reported to their length). The decommissioning and abandonment of sewerage networks is mostly observed in rural areas and un the mono-specialized and intensive ruralised small towns.

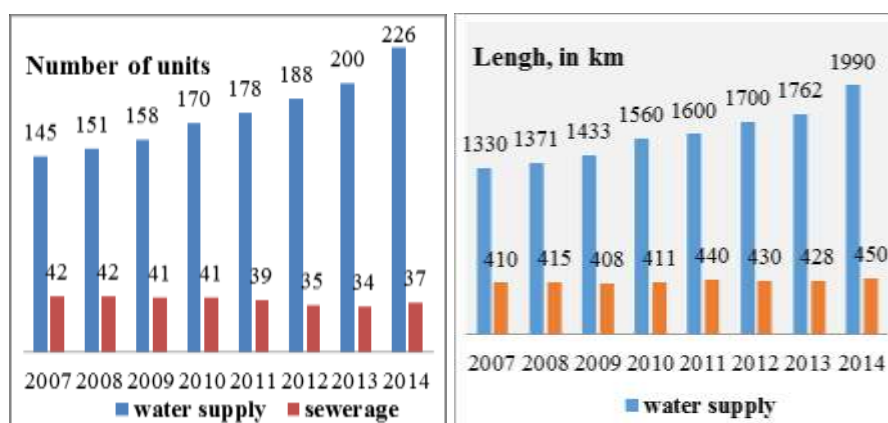


Figure 4. Dynamics of water supply and sewerage systems in the Prut river Basin Source: elaborated by author after NBS Reports on water supply and sewerage systems

The extension of water supply infrastructure requires to be accompanied by a similar expansion of the sewerage network. These requirements have been included recently both in the legislative acts regulating in this field and the water supply services. Also, the environmental and regional funds assure funding of this projects. Despite their mandatory character these requirements are often not respected.

The total capacity of waste water sewerage and treatment systems is over 95,000 m<sup>3</sup>/day and only 28% of it are used (table 2).

Table 2. Sewerage and wastewater treatment services at the enterprises of the Association "Moldova Apă-Canal" located in the Răut river basin (2014)

No.	TAU	Number of sewerage systems		Length of sewerage network, km		Number of pumping stations		Treatment stations		
		Total	Apă-Canal	Total	Apă-Canal	Total	Apă-Canal	Capacity, thousand m <sup>3</sup> /day	Usage degree, %	Apă-Canal
1	Dondușeni	4	1	37,2	15,6	3	2	2,4	2,4	11
2	Drochia	4	2	53,2	45,5	5	4	4,1	3,5	17,7
3	Florești	12	2	51,2	34,1	8	3	7	5,3	10,8
4	Sângerei	4	1	31	9,4	3	1	0,6	0,6	46,8
5	Râșcani	4	1	23	20	2	2	2,4	2,4	10,8
6	Bălți	2	1	152	152	6	6	60	60	34,7
7	Telenești	2	1	29	14,8	2	3	3,5	3,1	9,2
8	Orhei	5	2	72	14,6	6	3	14,8	14,6	15,3
	<b>Răut basin</b>	<b>37</b>	<b>12</b>	<b>450</b>	<b>306</b>	<b>35</b>	<b>24</b>	<b>95</b>	<b>92</b>	<b>28</b>
	<b>Totally RM</b>	<b>156</b>	<b>48</b>	<b>2663</b>	<b>2187</b>	<b>209</b>	<b>125</b>	<b>687</b>	<b>649</b>	<b>27</b>

**Sources:** table 2-3 are elaborated by author on the basis of NBS Reports on the sewerage systems, amac.md [1;7]

That is conditioned by economic and demographic decline of the served towns, as well as very high (over 50%) of the wear and tear sewerage and waste water treatment installations. Disastrous technical condition and superficial control of the sources of pollution, water pollution, very low payments and episodic offenders' punishing generate, on the whole, a great impact on water and human body.

The total volume of wastewater discharged through the sewerage network is ≈11 million m<sup>3</sup>, out of which 9,2 million m<sup>3</sup> by the enterprises „Apa-Canal” (Table 3). The amount of discharged wastewater is conditioned by number and size of urban and industrial centers. Thus, the maximum volume of discharged wastewater is found in the Bălți city (9 million m<sup>3</sup>) and in the districts of Orhei, Drochia and Florești, and the minimal one in the districts of Telenești and Donduseni [1]. Also,

the minimum values in the Râșcani district is conditioned by the location of majority of these district centers outside of the Răut river basin.

On average,  $\approx 36\%$  of discharged wastewater comes from households, and 10% from economic agents. In the last time, significantly decreased the share of industrial enterprises, but increased the share of budgetary organizations, commercial and service centers. Over half of the discharged wastewater is insufficiently treated as confirmed by local environmental authorities.

Table 3. Wastewater discharged into the Prut river basin per categories of users

No.	TAU	Total		Population			Economic agents			Insufficiently purified	
		Total thousand m <sup>3</sup>	Apă- Canal thousand m <sup>3</sup>	Total thousand m <sup>3</sup>	Apă- Canal thousand m <sup>3</sup>	%	Total thousand m <sup>3</sup>	Apă- Canal thousand m <sup>3</sup>	%	Total thousand m <sup>3</sup>	%
1	Dondușeni	114	96,1	85,2	78,6	74	6,8	6,8	6	96,1	100
2	Drochia	227	227	175	174	77	39,8	39,8	18		
3	Florești	211	209	121	121	57	72,5	70,8	34	58,1	28
4	Sângerei	156	102	91,3	68,7	59	21,4	6,6	14	102	100
5	Râșcani	95	95	69	53	73	21	21	22	95	100
6	Bălți	8912	7595	2981	2156	33	662	715	7,4		
7	Telenești	104	104	33,5	33,5	33	5,5	5,5	5,4	104	100
8	Orhei	1025	815	325	322	32	283	283	28	815	100
	<b>Răut basin</b>	<b>10844</b>	<b>9243</b>	<b>3881</b>	<b>3007</b>	<b>36</b>	<b>1112</b>	<b>1148</b>	<b>10</b>	<b>1271</b>	<b>14</b>
	<b>Total R M</b>	<b>65942</b>	<b>63977</b>	<b>38754</b>	<b>38275</b>	<b>60</b>	<b>9825</b>	<b>9170</b>	<b>20</b>	<b>4534</b>	<b>7</b>

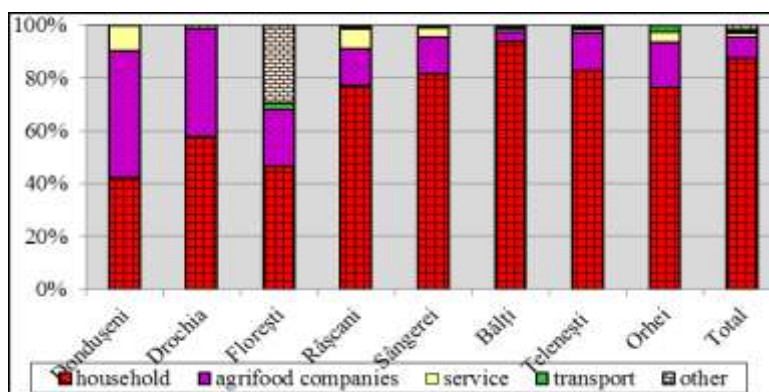


Figure 5. The branch structure of total volume of wastewater discharged into Raut river basin [10]

The branch structure of discharged wastewater varies from one district to another, but in the most districts, the highest percentage holds the municipal sector, which discharge about 88% of the total volume of water, particularly in Balti city (figure 5). The second position are agri-food companies, 8%, among which: canneries from Orhei (189 thousand m<sup>3</sup>), sugar factories from Donduseni (156



thousand m<sup>3</sup>) and Drochia (122 thousand m<sup>3</sup>), grain processing factories from Balti, Floresti, Drochia; Râșcani [10], dairies from Balti (104 thousand m<sup>3</sup>), Drochia and Râșcani, wineries from Orhei (55 thousand m<sup>3</sup>) and Telenesti, poultry factories from Donduseni, Riscani, Telenesti etc.

The absolute majority of sufficiently treated water were discharged from Balti city, which determined the general situation of water treatment in the Raut river basin. At the same time, in this basin are discharged, on average, 2,8 million m<sup>3</sup> of insufficiently treated waters. The absolute majority (83%) of these waters is discharged by the communal (municipal) companies from Drochia, Sângerei, Râșcani, Florești, Telenesti and Orhei. Also, insufficiently treated waters are discharged by sugar factory from Drochia, wineries from Sangerei and Orhei, juices and canned factory „SA Orhei Vit”, hospitals from districts centers [10].

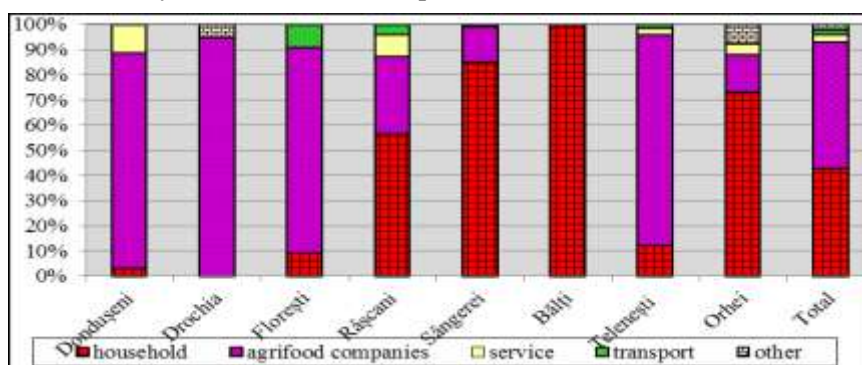


Figure 6. The branch structure of untreated wastewater discharged into Raut river basin [10]

The volume of wastewater discharged without treatment is, on average, 550 thousand m<sup>3</sup> (5%). The largest amount (55%) of wastewater without treatment comes discharged by agrifood companies from Donduseni, Drochia, Floresti and Telenesti (fig. 6), followed by communal enterprises (33%). In the Florești districts and Balti city are subject to treatment only wastewater discharged by communal enterprises.

The main pollutants discharged with wastewater discharged from of communal companies are CBO<sub>5</sub>, CCO, Cr, nitrogen, phosphorus, suspended solids, detergents, extractable substances etc. Wastewater from food industry are represented by water for transporting and washing of raw materials, volatile substances, process water, condensate or cooling waters, waters from washing and disinfection of premises processing and packaging machinery, water from sanitary installations, noxious oils etc. These waters contain high concentrations of nitrogen, phosphorous, and chloride, high concentrations of oils, fats organic matter: proteins, sugars, large amounts of suspended solids.

**Conclusions:**

Over 80% of waste water are discharged by enterprises from Balti, most of which are normative purified, which outlines the general situation of this basin.

In the Raut river basin about 75% of discharged wastewater was sufficiently treated, 20% are insufficiently treated, and 5% of wastewater are untreated. In the branch structure of the total volume of discharged wastewater and those insufficiently treated detached prevails the communal enterprises, followed at a long distance by the agro industrial complex and by service enterprises.

In the agro industrial complex is noted sugar factories in the Upper Course and Middle Course, wine companies in the Lower Course, grain elevators and bakery companies, poultry factories, dairies and meat products, and in the sphere of service: health, educational and shopping centers.

As a result of acute disrepair and insufficient sanitation facilities and wastewater treatment, water quality Raut River has a high level of pollution that exceeds several times the maximum allowable concentrations of key pollutants.

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