Environmental Engineering and Management Journal November/December 2009, Vol. 8, No.6, 1439-1450
http://omicron.ch.tuiasi.ro/EEMJ/

"Gheorghe Asachi" Technical University of Iasi, Romania

Environmental Integrated Management and Policy Making

ASSESSMENT OF HUMAN AND NATURAL IMPACTS OVER WATER QUALITY IN THE PRUT RIVER BASIN, ROMANIA

Carmen Teodosiu[*1], Claudia Cojocariu[1], Corina Petronela Musteret[1], Ioana Gabriela Dascalescu[2], Ionut Caraene[3]

[1] *"Gheorghe Asachi" Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, Department of Environmental Engineering and Management, 71 Mangeron Blvd., 700050 Iasi, Romania*
[2] *Department of Quality and Environment, Water Company APAVITAL SA, 6 Mihail Costachescu Street, 700495 Iasi, Romania*
[3] *Department of Project Implementation and International Relations, Water Prut Directorate, "Romanian Waters" National Administration, 10 Th. Vascauteanu Street, 700462 Iasi, Romania*

Abstract

The *Integrated Water Resources Management* (IWRM) concept evolved over time, the focus on river basin management, consultation and coordination with all water users, and the use of the "*polluter pays*" principle being all included in the EU Water Framework Directive (EC Directive, 2000), which forms the basis of water management undertaken in Europe.
The role and significance of water resources for sustainable development, as well as the water crisis experienced nowadays are influenced by water management, indicating the need for optimum management strategies and associated implementation alternatives. The integrated approach requires adequate information and communication within a structure that groups different stakeholders (industry, agriculture, other types of water users, civil society representatives, universities, research institutions, water authorities, waterworks companies), being thus characterized by a high level of complexity, and requiring the involvement of numerous decision-makers operating at different levels. Within the integrated approach, the association with specific policies and legal frameworks, *multidisciplinary research* (sciences, engineering, management), *education and training*, *communication, public participation* and *cooperation* at both national and international scale should be dealt with in a system that consider WATER flow and usage in its whole cycle of *supply, use* and *reuse/recycling*.
This paper presents an overview of the water quality problems in the Prut River Basin (Romania), by critically analysing the environmental particularities of the river basin, the major natural and human/industrial related impacts, the specific pollutant inputs and hydro-morphological pressures as well as the water supply and demand evolution in the last 3 years. This study is part of a complex research project that envisages the creation of technical and economical support systems for integrated water resources management in Romania (STEDIWAT project).

Key words: integrated water resources management (IWRM), water quality, priority pollutants

1. Introduction

Water represents one of the critical resources of sustainable development, through its position as a basic resource, but also due to its essential contribution to development, life support and eradication of poverty. Human activities and processes of all types – demographic, economic and social – can produce pressures on water resources, as well as negative impacts and need to be managed. These pressures are in turn affected by a range of factors such as technological innovation, institutional and financial conditions and climate change. The rapid global rise in living standards combined with population growth presents the major threat to the sustainability of water resources and environmental services (UNWWDR, 2009).

Although unevenly distributed for different categories (rivers and lakes, groundwater, and oceans, glaciers, etc.), at both regional and global scale, the

* Author to whom all correspondence should be addressed: e-mail: cteo@ch.tuiasi.ro, Phone: +40 232 237594

world has important water resources. However, the unequal distribution over the world, the mismanagement, limited resources and environmental changes mean that almost one-fifth of the planet's population still lacks access to safe drinking water and 40% of the population lack access to basic sanitation. Industry and agriculture are the most important users, in terms of water consumption and wastewater discharges, at the same time producing the biggest impacts (most of them negative from the environmental point of view) (Teodosiu, 2005). *Sustainable water management* relies on the coordinated development and management of surface water, groundwater and land use at a hydrological basin level (EC Directive, 2000).

The concept of Integrated Water Resources Management (IWRM) was given by the Global Water Partnership Technical Committee as "*The process that promotes the coordinated development and management of water, land and related sources in order to maximize the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems*" (GWP, 2004). This strategic concept includes the coordinated development and management of surface water and groundwater, river basins and its adjacent coastal and marine environment, land use, upstream and downstream interests, but also aspects related to the human capacity to use and benefit of this important natural resource.

Currently in Romania, water management complies with the European Water Framework Directive (EC Directive, 2000), in the sense that water management authorities are organized on river basin levels, but their efficiency related to the sustainability and integrated management of water resources is limited due to organizational problems and especially due to lack of coordination between governmental organizations, lack of communication and cooperation at the level of ***stakeholders*** involved in water resources management (*industry, agriculture and other types of water users, civil society representatives, university and research institutions, water authorities and waterworks companies*). These problems are most visible in periods of extreme water-related phenomena like droughts and floodings which, unfortunately, have become more and more present in the late period, with major environmental, social and economical impacts in the last years in Romania (Teodosiu, 2007).

Apart from the legislative and organizational support provided by local and national/regional authorities, the IWRM concept cannot be implemented without *technical and management instruments and enabling frameworks applied at the level of stakeholders consortia*, such as: novel techniques for monitoring and data management, GIS modeling tools, innovative and integrated concepts for water distribution, water use and recycling, management strategies, evaluation and reduction of negative environmental impacts on water through all its cycle, knowledge transfer and educational programs for sustainable and integrated water resources management, etc.

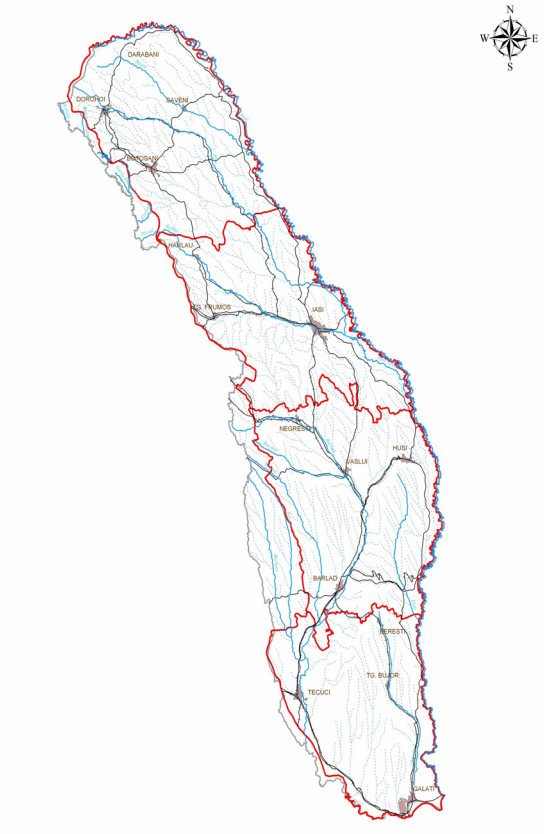


Fig. 1. The Prut River Basin

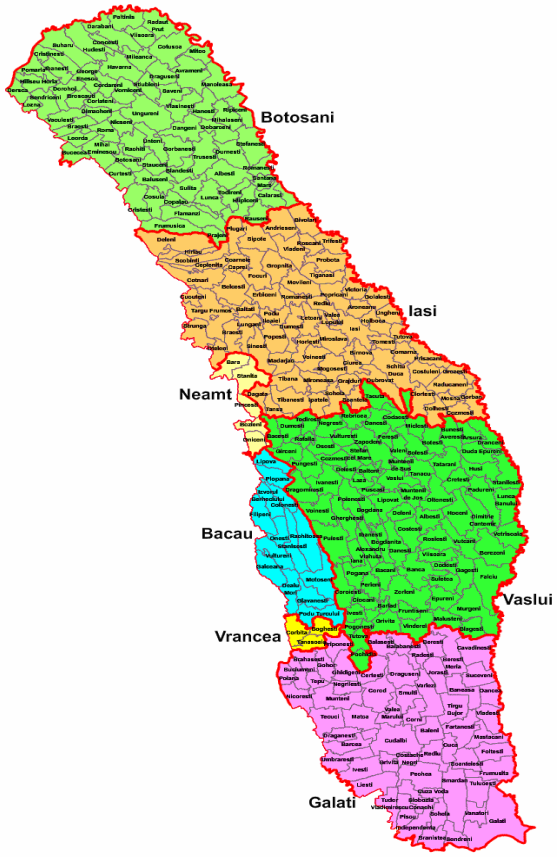


Fig. 2. The administrative allocation of the Prut River Basin

In the framework of PNCDI II (National Research, Development and Innovation Programme of the Romanian Ministry of Education and Research), a consortium lead by the "*Gheorghe Asachi*" Technical University of Iasi which has as partners *Politehnica* University of Timisoara, *Politehnica* University of Bucharest, *Transilvania* University of Brasov has received financing through grant competition for the STEDIWAT project (STEDIWAT, 2008). The acronym STEDIWAT stands for "***Technical and Decision Making Support System for Sustainable Water Management***" and the project duration is of 3 years (2008-2011).

This project has as the main objective to develop a support system that will provide a scientific base for decision-making and will contribute to knowledge transfer, regional, national and international cooperation of stakeholders and implementation of the Integrated Water Resources Management in Romania. This project deals with *integrated* issues related to the water cycle, supply, treatment, use and reuse at the level of stakeholders considering their interaction at the level of four basins in Romania (Prut-Barlad, Banat, Arges – Vedea and Olt river basin) (STEDIWAT, 2008).

This paper presents an overview of the water quality problems in the Prut River Basin (situated in the North- Eastern part of Romania), by critically analysing the environmental particularities of the river basin, the major natural and human/industrial related impacts, the specific pollutant inputs and hydro morphological pressures, as well as the water supply and demand evolution in the last 3 years.

2. Prut River Basin and its environmental particularities

The Prut River is the last tributary of the Danube River which makes confluence at 150 km upstream of river mouth in Black Sea. The length of the drainage system totalizes, on the surface of 3 countries (Ucraina, Romania and Moldova), 11,000 km, out of which 3,000 km have permanent water flow (Baseu, Jijia, Bahlui) and almost 8,000 km with intermittent water flow (Management Plan, 2008). The Prut River Basin has a 20,267 km^2 total surface (Fig. 1). From an administrative point of view, the Prut River Basin occupies entirely Botosani, Iasi, Vaslui and Galati counties, and partially the counties: Neamt, Bacau and Vrancea (as presented in Fig. 2).

In the Prut River Basin the average amount of precipitations is 400 - 600 mm per year. Air flow with a strong degree of eastern continentalism brings in this geografical area, droughty summers and cold winters with dry winds. In the Prut River Basin there are 4 hydrological stations and 14 weather stations.

In the Romanian part, Prut basin is managed by the Prut Water Directorate and includes in its patrimony: 52 reservoirs (with a total volume of 707 million m^3, divided in: 36 complex reservoirs, 11 temporary storages and 5 polders), 854 km of regularizations, 1073 km of dikes, 73.3 km of bank consolidations, 6 derivations-upstream waterways and 11 pumping stations. The groundwater resources in the basin are estimated being at 460.4 million m^3. There are limited resources in the case of phreatic groundwaters and of those with medium and high depth (50-300 m) where the usable resource is about 251.4 million m^3 (Management Plan, 2008).

3. Major natural and human/industrial related impacts

Land use in the Prut River Basin (Fig. 3) is influenced by physical and geographical conditions, and also by antropical factors. Agriculture includes animal farms and the cultivation of arable lands, with mainly maize, potatoes, sunflower, sugar beet. The total agricultural area is about 68.2% (12,406.2 km^2) of the Prut River Basin (Management Plan, 2008).

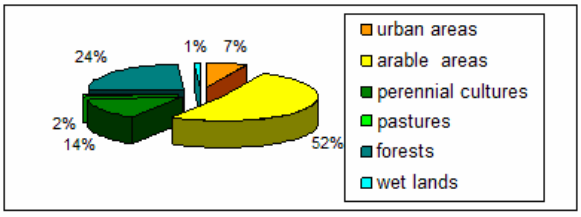


Fig. 3. Land use in the Prut River Basin

The main industrial activities developed in the counties that are included within the Prut River Basin influence are: machinery and industrial equipment manufacturing, textiles, clothing, glassware and ceramics, steel, as depicted in Table 1.

Influences of demographic factors in the Prut River Basin

Prut River Basin lies on the surface of 7 counties where a total of 2,277,678 people live, 1,120,160 of them in urban areas and 1,157,518 in rural areas (Master Plans, 2007). Distribution of river basin by counties is different depending on the existing drainage system and the establishment of the watershed between catchments of Siret and Prut Rivers, such as counties Botosani, Iasi, Vaslui, Galati have a rate of 90-100% and Bacau, Neamt and Vrancea in smaller proportions (Table 2).

Total number of inhabitants in the Prut catchment ranges between 680,656 inhabitants in Iasi County and 6,272 in Vrancea County (Table 3).

4. Impact of industries on the quality of receiving waters

In the Prut River Basin 124 water users discharge wastewater directly into natural receiving waters (rivers).

Table 1. Distribution rate by county of the industrial and agricultural products in the Prut River Basin

Products / County	Industrial production	Agricultural production
Botosani	garments, footwear, synthetic fibers and yarns, glass, bricks and ceramic blocks, meat products, milk and derivatives, sugar.	wheat, rye, barley, maize, sunflower, sugar beet, potatoes, onions.
Iasi	garments, steel pipes, raw steel, synthetic fibers and yarns, glass, precast concrete, bricks and ceramic blocks, medicines, meat products, milk and derivatives, oil, beer.	wheat and rye, vegetables, maize, sunflower, sugar beet, potatoes, grapes.
Vaslui	bearings, gears, measurement devices, abrasive products, garments, yarn and synthetic fiber, oil and meat products, milk products, winery	corn, industrial crops, maize, sunflower, grapes, fruit.
Galati	steel strips and sheets, steel wire, shipbuilding, metal	wheat and rye, vegetables, maize, sunflower, sugar beet, potatoes, milk, juice.

Table 2. Administrative and demographic characteristics of the territory in the Prut River Basin

No.	*County*	*Area (km^2)*	*% from total surface of Prut River Basin*	*Population (inhabitants)*	*% from total population of Prut River Basin*
1	Botosani	4,782	23.60	443,558	19.47
2	Iasi	4,564	22.52	680,656	29.89
3	Vaslui	5,318	26.24	452,832	19.89
4	Neamt	172	0.85	6,533	0.28
5	Bacau	946	4.67	40,372	1.77
6	Vrancea	157	0.77	6,272	0.27
7	Galati	4,328	21.35	647,455	28.43
Total		20,267	100	2,277,678	100

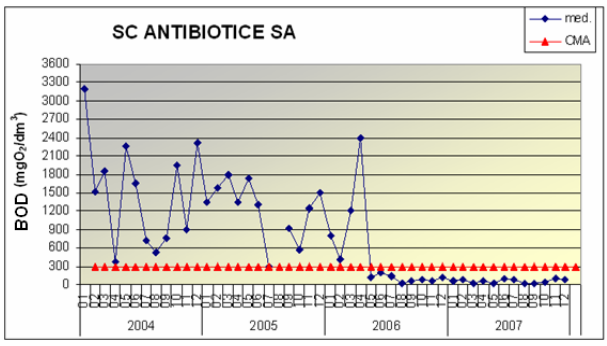
Table 3. Distribution of population by county in the Prut River Basin in 2006

No.	*County*	*No. of inhabitants*		
		Rural	*Urban*	*Total*
1	Botosani	274,131	169,427	443,558
2	Iasi	324,647	356,009	680,656
3	Neamt	6,533	-	6,533
4	Vaslui	274,624	178,208	452,832
5	Vrancea	6,272	-	6,272
6	Bacau	40,372	-	40,372
7	Galati	230,939	416,516	647,455
Total		1,157,518	1,.120,160	2,277,678

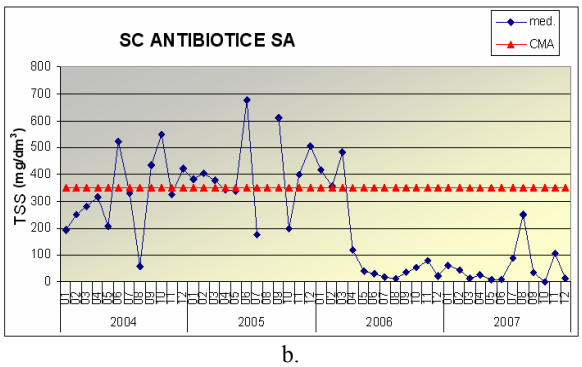
After analyzing concentrated pollution sources, a total of 329 concentrated pollution sources (286 of them are urban, 33 are industrial and 10 are agricultural) were revealed.

In Iasi County the major water and wastewater treatment works are provided by *Apa Vital*, a company that supplies the drinking and industrial water and also provides treatment for the municipal wastewater and sludge. The major responsible for water quality, including the necessary infrastructure for hydrotechnical works and protection against flooding is the Prut Water Directorate.

Below is a characterization of the main wastewater sources from Iasi that influence the receiving water quality of Prut River through *direct* discharges or *indirect* discharges (industrial wastewater discharged first into the sewerage system), due to increase of pollutant concentrations over *maximum accepted limits* (CMA) (Apa Vital Report, 2007; Law 107, 1996):

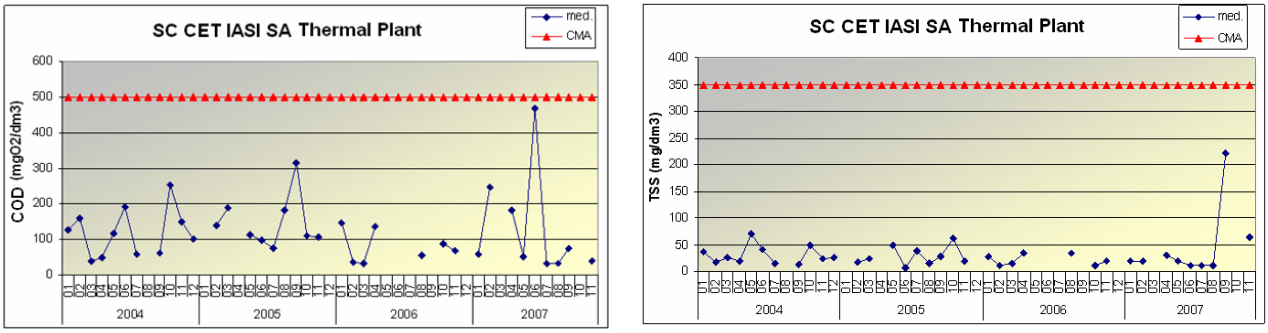


a.



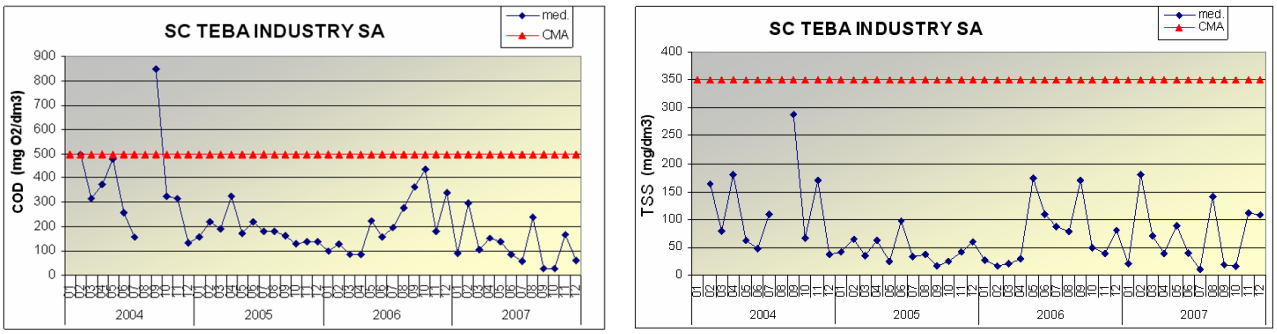
b.

Fig. 4. Dynamics of discharged effluent quality from SC Antibiotice SA Iasi in terms of: a-BOD; b-TSS (CMA - maximum accepted concentrations)



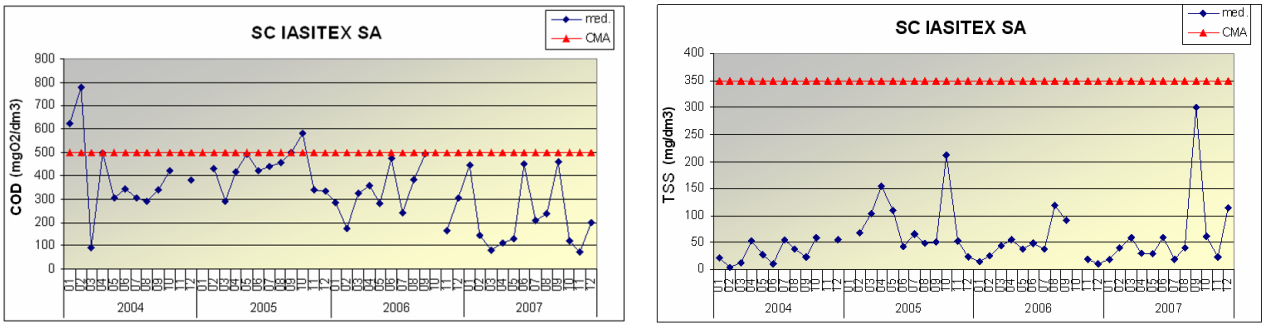
a. b.

Fig. 5. Dynamics of discharged effluent quality from CET thermal plant of Iasi in terms of: a-COD; b-TSS (CMA- maximum accepted concentrations)



a. b.

Fig. 6. Dynamics of discharged effluent quality from SC TEBA INDUSTRY SA Iasi in terms of: a-COD; b-TSS



a. b.

Fig. 7. Dynamics of discharged effluent quality from SC IASITEX SA Iasi in terms of: a-COD; b-TSS

At **SC ANTIBIOTICE SA Iasi** (activity in pharmaceutical industry, target covered by the Integrated Pollution Prevention and Control - IPPC - Directive), the water quality data analysis show a positive trend of the discharged effluent quality. Lower concentrations were found in 2006, and 2007 compared with previous periods monitored (Fig. 4). SC Antibiotice SA Iasi has a pre-treatment station and has decreased its pollution loads for the municipal wastewater treatment plant due to technological changes made, which provides reliability of operation and effluent water quality. Fig. 4 presents the evolution of the biochemical oxygen demand indicator (BOD) and of the total suspended solids for the period 2007 – 2007, with a significant decrease after introduction of pre-treatment station.

Within the **Iasi thermal plant** (produces heat and power based on fuel oil and natural gas, target covered by the IPPC Directive - the effluent quality monitoring recorded a high value in April 2007 (almost 100% over the permitted limit for the petroleum hydrocarbons. The penalties imposed and monitoring performed weekly by APA VITAL Iasi and also joint actions in water management and environmental authorities determined this economical agent to improve the installation of retention petroleum hydrocarbons blown with wastewaters. Fig. 5 presents the evolution of wastewater quality with respect to concentration of organics, represented by the chemical oxygen demand indicator (COD) and total suspended solids.

SC TEBA INDUSTRY SA (textile industry target) has made progresses in the quality of wastewater discharges, after putting into operation of the upgraded wastewater pre-treatment technology. Since 2004, after installing the automated treatment

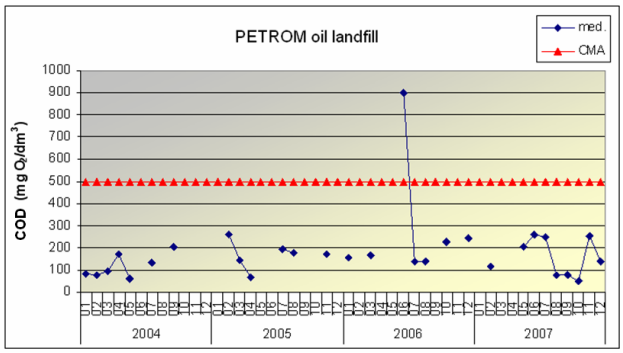
equipment with ferrous sulphate and lime, for dyes precipitation and modernization of sludge processing, wastewater with quality subscribed to acceptable limits as provided by NTPA 002 (GD, 2005) (indirect discharges) resulted. In Fig. 6 graphic variations of effluent quality discharged from SC TEBA INDUSTRY SA Iasi are shown.

SC IASITEX SA (textile industry target) restarted functioning after a period of production decrease (2003 - 2005), in addition with the change of executive team in 2006. The existing pre-treatment works (based on dyes precipitation technology with ferrous sulphate at an adequate pH) were reinstalled with the improvements at the factory level. The current concentrations of the effluent exceed the acceptable level of dyes and other toxic substances used in the technology. It should be mentioned that during the years 2005-2007 discharges of colored wastewater in the sewage network were recorded (Fig. 7). After that, the discharges of dyes in water were reduced by a proper operation of the pre-treatment station (Apa Vital Report, 2007).

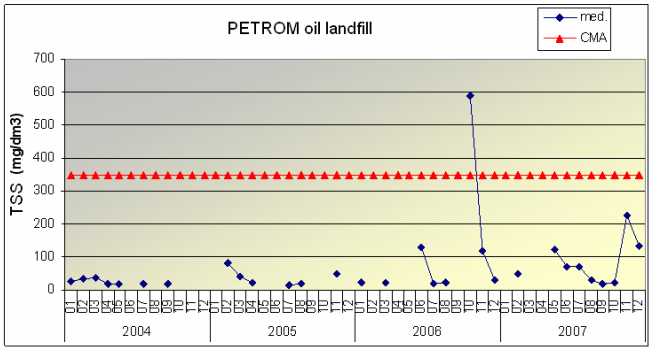
PETROM oil landfill stores petroleum products (petrol, diesel) and for a long time it was a source of contamination of the city sewerage system with oil products and wastes. In 2007, improvements have been made in process handling, with the proper dosages of hazardous substances (as tetraethyl lead, mineral oils and additives for diesel), the petrol etiolating and gasoline additiving processes were stopped. In Fig. 8 graphic variations of the effluent quality discharged from PETROM oil landfill are given.

Within **SC TEROM SA** (IPPC target in production of synthetic fibers) there were real changes in the period 2004 - 2006, by successive changes of ownership, the activity of the factory being progressively interrupted, until total stop in 2006. Also, in 2006, the decommissioning of polycondensation set-up, a main source of non-biodegradable organic pollutants occurred. The decommissioning process was followed by the collection of hazardous substances existing in the facility and safe storage in order to recover/eliminate it, so that polluting activity decreased. From the examination conducted by the audit team resulted also the use of hazardous substances, including dyes, which leaded to further monitoring of this trader. SC TEROM SA still creates difficulties in monitoring effluents discharges and establishes responsibilities and obligations to discharge an effluent in the common city sewerage system, according to NTPA 002/2005 (GD, 2005). In Fig. 9 graphic variations of the effluent quality discharged from SC TEROM SA Iasi are shown.

SC ASAM SA has metallurgic activities (heat treatment, galvanic coating, phosphatizing), being an IPPC target. Monitoring of the wastewater effluent and rainfall system (in conditions of rainfall, the hazardous substances from the ground enter into the sewerage system) has revealed the existence of fluctuations of the heavy metals concentrations, with recorded values exceeding 10 times the limits, in 2006. This had led to the intervention audit of Apa Vital Iasi, to improve self-monitoring and eliminate peak concentrations discharged into drains.

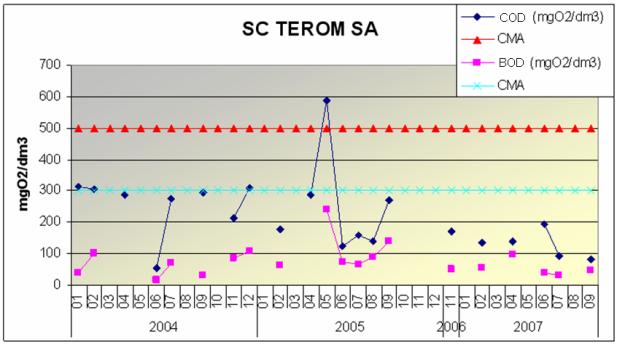


a.

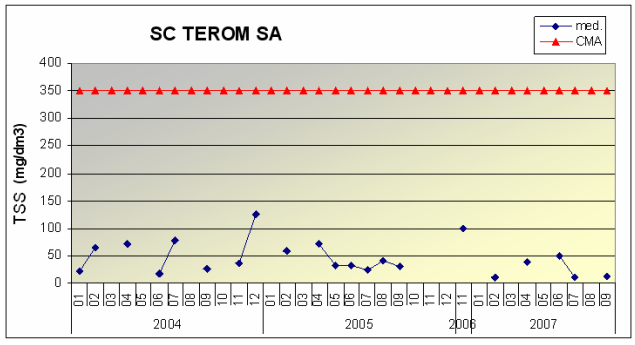


b.

Fig. 8. Dynamics of discharged effluent quality from PETROM Iasi in terms of: a-COD; b-TSS

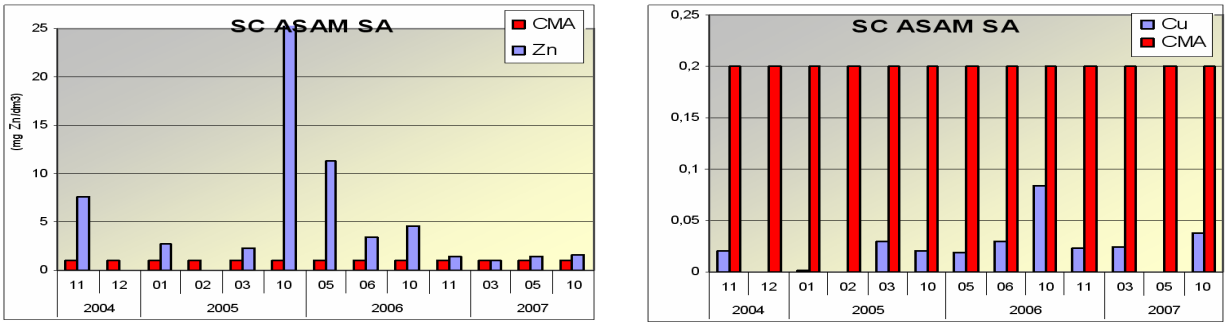


a.



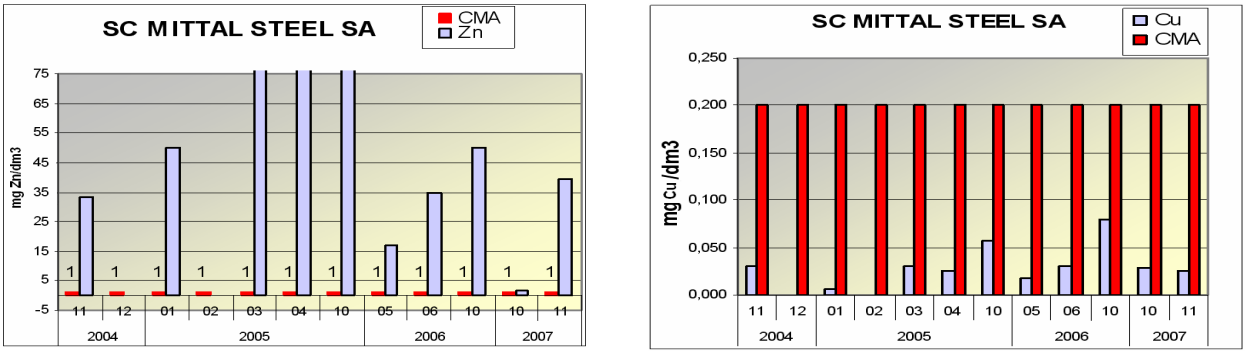
b.

Fig. 9. Dynamics of discharged effluent quality from SC TEROM SA Iasi in terms of: a-BOD and COD; b-TSS



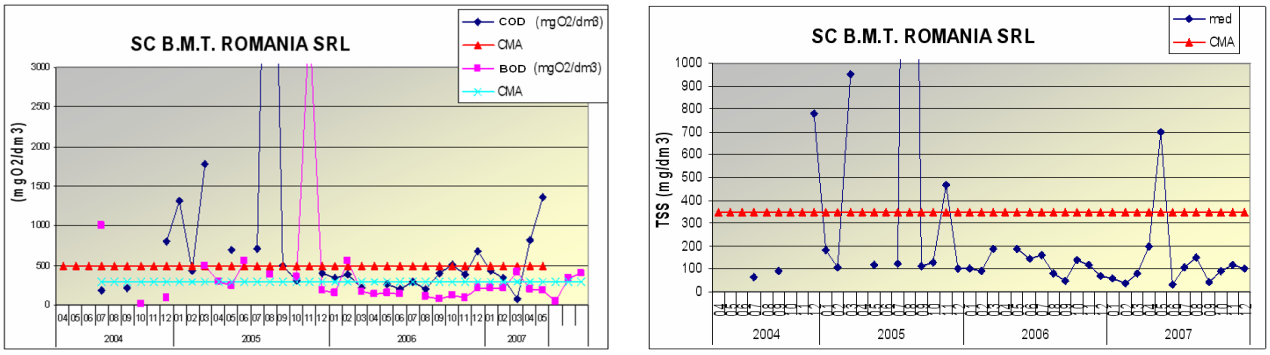
a. b.

Fig. 10. Dynamics of discharged effluent quality from SC ASAM SA Iasi in terms of: a - Zn^{2+}; b - Cu^{2+} concentrations



a. b.

Fig. 11. Dynamics of discharged effluent quality from SC MITTAL STEEL SA Iasi in terms of: a- Zn^{2+}; b- Cu^{2+} concentrations



a. b.

Fig. 12. Dynamics of discharged effluent quality from SC BMT SA Iasi in terms of: a-BOD and COD; b-TSS concentrations

The company had completed the project on construction of an automatic sludge system, which corresponds to the best available technologies (BATs) for this industry. In 2007, they have ensured the retention of pollutants in existing pre-treatment plants, the exceeding concentrations being decreased with approx. 50%. Fig. 10 presents the graphic variations of the effluent quality discharged from this target.

SC MITTAL STEEL SA has metallurgic activities too (heat treatment, galvanic coating, phosphatizing). Due to significant capacity of this operator, it represents a significant source of pollution for the city sewerage system with heavy metals, suspended solids (sludge resulting from treatment of acid wastewater), petroleum, oil. Thus, there were very high pollution loads registered for the total zinc concentrations in December 2005, due to zinc coating activities. In Fig. 11 the graphics show variations of the effluent quality discharged from the operator.

SC BMT SA (machinery construction industry) is, currently, a potential source of pollution, considering the introduction of cyanide electroplating technology. In an action endorsed by the local environmental and water management authorities, approved also by Apa Vital Iasi, it was imposed water decontamination aiming to eliminate cyanide and copper concentrations from wastewaters. The wastewater treatment operator Apa Vital Iasi set severe measures to monitor the entire process. Further examinations made at the operator revealed water without cyanide, but concentrations of copper having

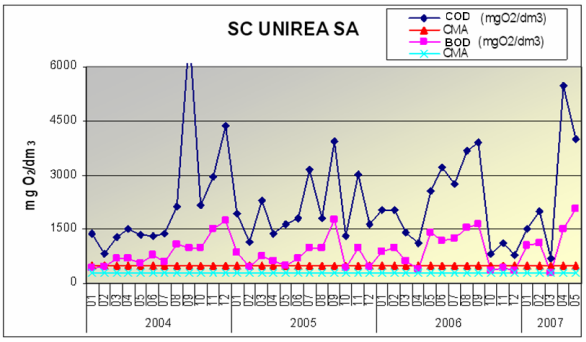
values of 1 mg/L, compared to 0.2 mg/L allowed by NTPA 002 (GD, 2005), for evacuation in the municipal sewerage system. Regarding the quality of wastewater discharges, there is another problem in the sources of extractable substances. This indicator in wastewater discharges was recorded at a value of 100 mg/L in 2007. However, so far, solutions for the problem of technological oil and emulsions wastewater effluent which transports extractable substances in the sewerage were not found. The wastewater pre-treatment made on-site by the factory should be considered as a necessary investment program that must achieve a good quality control of the discharged wastewater. In Fig. 12 the variations of the effluent quality discharged from the SC BMT SA Iasi are presented.

Wastewater effluent quality from the **SC UNIREA SA** (alimentary oil industry) is inconsistent according to NTPA 002 (GD, 2005). Water saving technology strategy resulted in increased levels of organic pollutants and especially of the total extractive substances. An indicator that presents inconsistent values, is the pH, which, according to the records, show values in the area of acid range, the maximum being at about 2-3 pH units. This company was obliged to reduce pollution loadings and to invest in the realization of pre-treatment facilities, but in the meantime the factory was closed due to economical reasons. Fig. 13 presents the graphic variations of the effluent quality discharged from SC UNIREA SA Iasi.

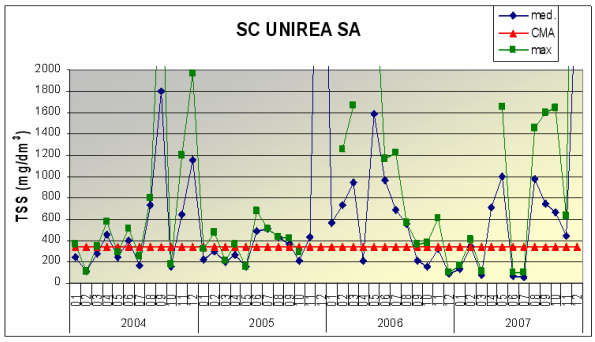
Within the **SC MOLDOMOBILA SA,** the results of the physical and chemical parameters concentrations loads were reduced in 2007, as a result of the measures taken within process technology modernization for achieving the integrated environmental authorization. Measures have been taken and progresses have been registered in the recovery of glue (involved in the process of washing the rollers to apply adhesive panels pressing process). These measures ensure that a high percentage of wastewater situates in the limits established by wastewater and sewerage system contract terms. It follows the final action that aims at expanding pre-treatment installations and replacement of hazardous substances that have to be made according to the terms set out in the compliance program. In Fig. 14 the graphic variations of the effluent quality discharged from SC MOLDOMOBILA SA Iasi are shown.

Other economical agents

In 2007 the development of business activities has led to the appearance of 3 major shopping centers: Kaufland, Selgros and Carrefour. The water quality data analysis conducted by APA VITAL, showed high concentrations of total extractive substances and organic substances, due to improper operation of provided pre-treatment installations. In order to achieve the allowed limits measures were taken so as to improve maintenance of plant and monthly frequency monitoring was established. It is mentioned that pollutants from the effluents are biodegradable and no disturbances were recorded in Iasi municipal treatment plant.

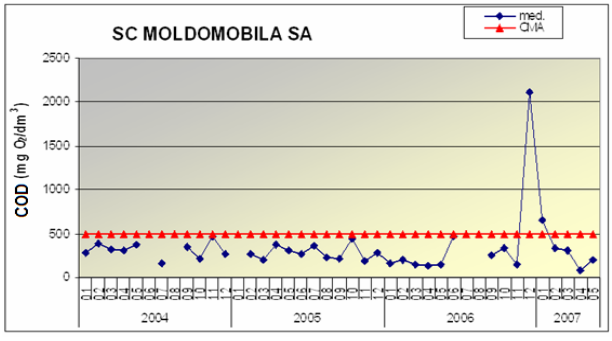


a.

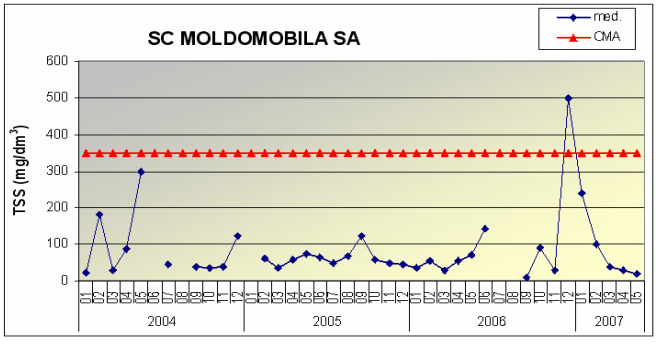


b.

Fig. 13. Dynamics of discharged effluent quality from SC UNIREA SA Iasi in terms of: a-BOD and COD; b-TSS



a.



b.

Fig. 14. Dynamics of discharged effluent quality from SC MOLDOMOBILA SA Iasi in terms of: a-COD; b-TSS concentrations

The Prut catchment includes several categories of works: reservoirs, derivates, adjustment, embankments and protection of banks, constructed on water bodies for different purposes (energy, water supply, natural flow regulation, defense against the destructive effects of flooding, excess humidity control, etc.), with functional effects for human communities.

There are 75 lakes with surface under 0.5 km^2, 49 of them are complex and mainly used for defense against floods. Lakes act as a hydromorphological pressure, mainly interrupting the leakage continuity and flow regulation. There are 26 reservoirs in the Prut River Basin, and the most important is Stanca-Costesti, with a total volume V_T of 1400 million m^3 which serves as defense against floods, and provider of water needs in this area (water supply for population, industry, agriculture, etc.) and also exploited for its hydropower potential.

Regulations and embankments

On the Prut River Basin territory, there are a number of 82 river-water bodies regulated on a total length of 1057.5 km. Analyzing their hydro-morphological parameters according to the criteria for defining significant hydro-morphological pressures, it reveals that total of 31 existing regulation (15 water bodies with over 70% regulation works).

Regulations and embankments produce as hydromorphological pressure mainly morphology changes of water courses, alterations of the hydraulic characteristics and disruptions of lateral continuity.

Derivatives

Four hydrotechnical targets from this category are designed to supplement the tributary flows to ensure minimum water requirements for water supply in some villages, and one of them (Munteni-Tecuci-Malul Alb derivative) acting as a diversion of high water. These works produce significant changes in water flow rates where they function. The derivatives, as a hydromorphological pressure produce mainly effects on minimum flow, the riverbed and biota stability.

Significant withdrawals/evacuations of water

Water withdrawals and refunds (evacuations) produce significant hydro-morphological alterations by altering the characteristics of the water course where are positioned the water inlets and the discharges whose debts taken/refund, are significant quantitative.

Economic units on the Prut River Basin area, whose flows are considered in quantitative terms hydromorphological pressures (significant hydro-morphological alteration), are:

– *water body Sitna downstream Catamarasti – upstream Dracsani*

SC APA GRUP SA Botosani S.E. (Q_{ev} = 0.373 m^3/s)

SC APA GRUP SA Botosani SP Tulbureni (Q_{ev} = 0.38 m^3/s)

– *water body Bahlui - confluence Bahluiet - confluence Jijia*

SC APA VITAL Iasi S.E. (Q_{ev} = 2.005 m^3/s)

– *water body Vaslui downstream Ac. + Rac*

GOSCOM Vaslui S.E. (Q_{ev} = 0.17 m^3/s)

– *water body Delea*

GOSCOM Vaslui - collection Delea (Q_{ev} = 0.0106 m^3/s) (Management Plan, 2007).

5. Water supply and demand particularities

The situation of treatment facilities and water treatment plants existing in the catchment analyzed should be correlated with the demographic situation in the river basin. In Table 4 the situation in the most important human agglomerations (>10.000 p.e.) in terms of connection degree to the sewerage and wastewater disposal system is described. It should be noticed that, part of them are discharging wastewater flows in two rivers, this fact highlighting the gravity of the water quality state in Sitna, Valea Seaca, Vaslui and Barlad rivers.

In Table 5, human agglomerations that have only sewerage networks, but insufficient, are presented. Barlad River is affected by two of these human agglomerations (Ivesti and Ghidigeni). The water quality of Barlad River is significantly influenced by the Crasna river (due to diffuse organic polluted due to poor sanitation), by the negative impact of Vasluiet river and by the contamination from Crivesti area due to wastewater treatment plant of the Barlad city and direct discharges from Barlad municipality.

In Table 6, there are shown the number of agglomerations (>2000 p.e.), the endowment situation with wastewater treatment plants considering organic biodegradable load expressed in "population equivalent" at the end of 2006.

Table 4. The situation in the most important human agglomerations (>10.000 p.e.) in terms of connection degree to the sewerage and wastewater disposal system

No.	*County*	*Population, p.e.**	*Length of sewerage system, km*	*Rivers affected by discharges*
1	Iasi	660,000	464.1	Bahlui
2	Galati	450,000	480	Danube
3	Botosani	250,000	325.1	Sitna, Teascu
4	Vaslui	95,000	117	Vaslui, Vasluiet
5	Barlad	80,413	163.5	Valea Seaca, Barlad

Table 5. The situation of human agglomerations that have only sewerage networks, but insufficient

+Human agglomeration	*Population, p.e.*	*The length of sewerage networks, km*	*Discharged flows (l/s) and affected rivers*
Liesti (Galati county)	16,650	3	3.076 L/s - Siret River
Ivesti (Galati county)	16,000	1.16	0.19 L/s - Barlad River
Ghidigeni (Galati county)	11,210	1.5	1.015 L/s - Barlad River
Flamanzi (Botosani county)	14,000	5	2.917 L/s - Miletin River
Holboca (Iasi county)	14,373	9	
Tomesti (Iasi county)	13,342	10	
Zorleni (Vaslui county)	10,516	5.4	

Table 6. Situation of human agglomerations, treatment stations, and total organic loads, collected and treated in the Prut catchment

Size of human agglomeration	*No. of human agglomeration*	*No. of wastewater treatment plants*	*Total organic load, p.e.*	*Collected organic load, p.e*		*Treated organic load, p.e*	
				p.e.	*%*	*p.e.*	*%*
> 150000 p.e.	3	2	1,360,000	1,173,600	86.29	581,684	42.77
15000 – 150000 p.e.	9	5	375,783	214,373	57.05	167,646	44.61
10000 – 15000 p.e.	21	8	257,722	32,006	12.42	3,117	1.21
2000-10000 p.e.	253	11	1,205,364	25,075	2.08	11,249	0.93
Total	286	**26**	3,198,869	1,445,054	45.17	763,696	23.87

It should be mentioned that there are 260 human agglomerations (> 2000 p.e.) which are not yet equipped with wastewater treatment plants and from the total of **26 wastewater treatment plants**, none of them comply with legislative requirements according to discharge limits of NTPA 002 (GD, 2005) (these plants will comply by implementing programs of action).

Public services of water supply, sewerage and treatment infrastructure in the Prut catchment consists mainly in: 36 drinking water treatment plants, 2529.1 km of drinking water distribution network, 1966.5 km sewerage network, 7 wastewater treatment plants with a treatment capacity corresponding to 1,413,502 population equivalent.

In Table 7 the characteristics of treatment stations are shown. From a total of 27 wastewater treatment plants only two of them have an advanced/modern wastewater treatment tertiary stage. The wastewater treatment plant of Barlad municipality (with a designed capacity of 256 L/s for the mechanical treatment stage and 340 l/s for the biological treatment stage) evacuates 200 L/s treated wastewater in Barlad River. Exceedances were found at the following indicators: hydrogen sulfide and total sulfur. In Iasi city, the exhaust flow from mechanical and biological treatment is 1343.385 l/s and 661.593 L/s is only mechanical treated. In Galati and Botosani counties and modernization programs with ISPA funds for the wastewater treatment system, are in progress (Water Quality Summary, 2008).

To implement and comply with the requirements of 91/271/EEC Council Directive of May 21, 1991 concerning urban wastewater treatment (EC Directive, 1991), Romania obtained the following transition periods:

- ***Collection of urban wastewater*** (Article 3 of the Directive), as follows:

• till December 31, 2013 the compliance with the directive will be made for 263 human agglomerations with more than 10,000 p.e.;

• till December 31, 2018 the compliance with the directive will be made for 2346 human agglomerations with more than 10,000 p.e.;

- ***Urban wastewater treatment and discharge*** (Article 4 (1a, b) and art. 5 (2)):

• till December 31, 2015 the compliance with the directive will be made for 263 human agglomerations with more than 10,000 p.e.;

• till December 31, 2018 in compliance with the directive will be made for 2346 human agglomerations with more than 10,000 p.e.

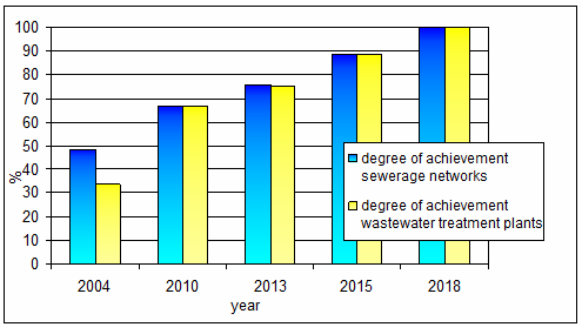


Fig. 15. Situation of connection to sewerage system and treatment stations in the Prut River Basin

In terms of connection to sewerage networks and wastewater treatment plants degrees which need to be completed by the deadline of compliance with the requirements of Directive 91/271 on the Prut catchment (Fig. 15), they must provide certain organic biodegradable load expected to be completed until 2018 (Table 8).

Table 7. Characteristics of treatment stations

Year	*Wastewaters treatment stations (WWTP)*		*WWTP with mechanical stage*		*WWTP with mechanical+ biological stage*		*Advanced/modern WWTP stations*	
	Total no.	Total capacity	Total no.	Total capacity	Total no.	Total capacity	Total no.	Total capacity
	no.	1000 p.e.	no.	1000 p.e.	no.	1000 p.e.	no.	1000 p.e.
2008	27	1,413.5	4	3.4	21	714.5	2	665.5

Table 8. Number of collection systems and wastewater treatment and population equivalent to comply with the end of transition deadline in the Prut catchment

Years	*Agglomerations with over 2000 p.e.*			
	Collection systems		*Wastewater treatment plants*	
	No.	Total p.e. conected	No.	Total p.e. conected
2010	27	2,083,511	8	2,082,095
2013	27	261,037	18	261,180
2015	58	405,494	54	405,571
2018	172	344,150	204	345,345
Total	284	2,094,191	284	3,094,191

Water price (for treatment, sewerage system, sanitation)

According with Article 34 from Law 241 (2006) (Sewerage and water supply services law), prices and charges to pay for water supply and sewerage services are based, set, adjusted, changed, approved and applied under Law no. 51/2006. Prices and charges for paying water and sewerage services are based on the costs of production and operation, maintenance and repair costs and they include quotations for interest payments and repayment of loans, costs for development and modernization of urban and technical systems, under the law, with the following conditions:

- the structure and the level of charges should be set to reflect the actual costs for providing of services for water and sewerage, to discourage excessive consumption, to encourage their efficient operation and environmental protection, to encourage capital investment and to be correlated with degree of supportability by users;
- the financial autonomy of the operator should be safeguarded and respected;
- the operator is entitled to propose rates binomial with: a fixed component, proportional to the necessary costs for maintaining in operational and functioning safety and efficiency of the water and sewerage system, and a variable, depending on water consumption, respectively on the quantity of wastewater, registered at the users;
- the operator is entitled to index periodically the charges depending on inflation rates, based on the indexing formulas approved by the regulatory authority and approved by local authorities responsible;
- the approving of the charges should be done by the local councils, county councils or, the General Council of Bucharest (where appropriate), in accordance with the legal requirements (Law 241, 2006).

In 2007 the National Administration together with the Romanian Water Association have initiated an interview of the public water and sewerage services operators, regional operators whose application has been approved by the Management Authority of the Operational Sectoral Program on Environment, the Ministry of Environment and Sustainable Development, resulting in a level of prices for public water and sewerage services, that are presented for for the Prut River Basin in Table 9.

Financing of the current activities of public services for water supply and sewerage is made by receiving the equivalent price from consumers, with the prices and charges approved by local authorities. Thus, operating activity is not subsidized and there is no practice of direct social protection systems to public water and sewerage services, the percentage of cost recovery in the services billed exceeds 100%, the difference being in the rate of development and profit rate determined in accordance with legislation.

Table 9. Level of prices for public water and sewerage services (Apa Vital Report, 2007)

2007 year / *Company*	*The price of household drinking water (RON*/m³)*	*The price of drinking water for industrial consumers (RON/m³)*	*The price of households sewerage (RON/m³)*	*The price of industrial consumers sewerage (RON/m³)*	*Observations*
SC APA GRUP SA Botosani	1.64	1.64	0.80	1.07	The charge for cleaning services is included in the rate of sewage
SC APA VITAL SA Iasi	2.22	1.91	0.99	0.99	
SC AQUAVAS SA Vaslui	1.68	1.68	0.74	0.74	
SC APA CANAL SA Galati	1.99	1.99	0.42	0.42	The headrace price: 1.4

Fig. 16 shows the evolution of water price in Iasi county, both for the drinking water (for households) and for the industrial consumers.

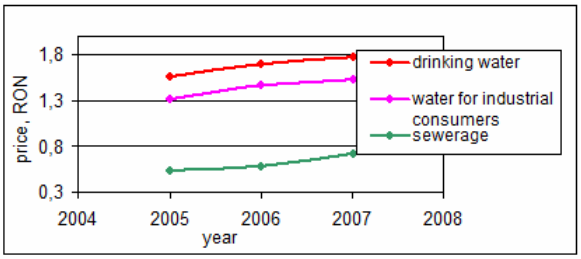


Fig. 16. Water price development between 2005 – 2008

6. Conclusions

This paper performs a critical analysis of the environmental context in the Prut River Basin, necessary for implementation of the integrated water resources management. Thus, the IWRM implementing process was studied starting at the river basin level, the environmental issues, the human and natural impacts, the availability and quality of water resources, the wastewater and sewerage infrastructure and also the water supply and demand mechanisms, the relation with water price dynamics being highlighted. Starting from the basin level the major negative issues were located and correlated.

In the Prut River Basin 124 water users that discharge wastewater directly into the rivers, were found. A total of 329 concentrated pollution sources (286 of them are urban, 33 are industrial and 10 are agricultural) were revealed.

The existing infrastructure is not enough developed and also non-functional in all respects (wastewater treatment plants, distribution networks, laboratories, information systems and monitoring). Problems are also encountered with lack of coordination and management support for stakeholders as well as for the application of pollution prevention and control measures at the level of industrial units.

In terms of wastewaters and sewerage services infrastructure, the connection to sewerage networks and wastewater treatment plants degrees need to be completed at deadline that comply with the requirements of Directive 91/271 on the Prut River Basin, which must provide certain organic biodegradable load.

The issues that have been analyzed in this article revealed the need to address the IWRM implementation by a unitary approach that considers technical and management instruments and adequate strategies so as to provide the necessary scientific and practical support for decision making and operation at the river basin level.

Acknowledgements

This study was realized with the support of STEDIWAT "Technical and decision making support system for the sustainable water resources management", Contract no. 32-125/ 2008 and BRAIN "Doctoral scholarships as an investment in intelligence" project, financed by the European Social Found and Romanian Government ID 6681.

References

Apa Vital Report, (2007), Apa Vital Water Work Company for water supply and sewerage services, Report, Iasi, Romania.

EC Directive, (1991), Directive 91/271/EEC of the European Parliament and the Council concerning urban waste water treatment, Official Journal OJ L135.

EC Directive, (2000), Directive 2000/60/EC of the European Parliament and the Council establishing a framework for the Community action in the field of water policy, Official Journal OJ L 327.

GD, (2005), Governmental Decision no. 352/2005 NTPA 002, Normative regarding wastewater discharge conditions into sewer networks of municipalities, *Romanian Official Monitor*, No. 398/11 May, 2005.

GWP, (2004), *Catalysing Change,* Global Water Partnership Technical Commitee: Elanders Press, Stockholm, Sweden.

Law 107, (1996), Water Law no. 107/1996 with its subsequent modifications and completions, Romanian official Monitor No. 244/8 October 1996.

Law 241, (2006), Law 241/2006 on the sewerage and water supply services, *Romanian Official Monitor,* No.60/25 January 2007.

Master Plans (2007), Masterplans of chatchments management in Romania - The management of important water issues, Romanian Waters National Administration and Ministry of Environment and Water, Romania.

STEDIWAT, (2008), Technical and Decision Making Support System for Sustainable Water Management, *Parteneriate* - PNCDI National Program, Contract no. 32-125, Romania, On line at: http://omicron.ch.tuiasi.ro/EEMJ/pdfs/vol8/no4/14_STEDIWAT.pdf.

Management Plan, (2008), Prut River Basin Management Plan of Water Directorate, Romanian National Waters Administration - Prut Water Directorate, Iasi, Romania, Iasi, Romania.

Teodosiu C., (2005), Integrated environmental management, IInd Edition, Ecozone Publishing House, Iasi, Romania.

Teodosiu C., (2007), Challenges for integrated water resources management in Romania, *Environmental Engineering and Management Journal*, **6**, 363-374.

Teodosiu C., Barjoveanu G., Lupu L., Volf I., (2007), Evaluation of process technologies for advanced treatment and recycling of industrial effluents, Conference Excellence Research – *A Way to ERA*, Section Environment and Health, Tehnical Publishing House, Bucharest, Romania.