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DAMBOVITA – 50 KM BETWEEN GOOD QUALITY AND ECOLOGICAL DISASTER

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Dambovita – 50 km between good quality and ecological disaster

Dumitru Marcoteț, Nina Jipa, Ludmila Maria Mehedințeanu

Dambovita - 50 km tra buona qualità e disastro ecologico. Dambovita è il principale corso d'acqua che attraversa Bucarest. Quindi, è l'acqua collettore delle acque reflue, industriali e pluviale generati all'interno della città, arrivando prima attraverso la rete fognaria al impianto di depurazione Glina. Quest'ultimo, però, non è ancora funzionale, dumping le aque reflue nel fiume senza trattamento preliminare, che portano ad una forte degradazione della qualità dell'acqua, che è in clasa scarsa qualità incorniciata iniziando dall punto della perdita Glina fino a che la fuoriuscita in Arges. Fare determinazioni delle principali proprietà fisiche e chimiche delle acque in punti scelti in modo da fornire una panoramica di come la loro qualità è subito a causa delle fonti di inquinamento nella zona di Bucarest, un generale degrado del fiume Dambovita da monte a torrente fu trovato, le cui acque contaminate influiscono la qualità condizione dell collezionista Arges, così come la freatica che si trova ad una distanza di diverse centinaia di metri da esso.

Parole chiave: Dambovita, Arges, determinazioni, qualità, degrado, Bucarest, Budesti.

Dâmbovița-50 km între calitate bună și dezastru ecologic. Dâmboviţa reprezintă principalul curs de apă care străbate Municipiului Bucureşti. Astfel, acesta se constituie în colectorul apelor uzate menajere, industriale şi pluviale generate pe teritoriul oraşului, care ajung mai întâi prin intermediul reţelei de canalizare la staţia de epurare de la Glina. Aceasta din urmă însă, nefiind încă funcţională, deversează apele uzate în râu fără o epurare prealabila, fapt ce determină o degradare accentuată a calităţii apelor acestuia, care se încadrează în clasa calitativă nesatisfăcătoare începând cu punctul de deversare de la Glina şi până la vărsarea în Argeş. Realizând determinări ale principalelor proprietăţi fizice şi chimice ale apei în puncte alese astfel încât să ofere o imagine generală a modului în care calitatea acestora are de suferit ca urmare a surselor de poluare din zona Municipiului Bucureşti, s-a constatat o degradare generală a Dâmboviţei dinspre amonte spre aval, ale cărei ape contaminate afectează starea de calitate a colectorului Argeş, precum şi a freaticului situat la distanţe de câteva sute de metri de aceasta.

Cuvinte cheie: Dâmboviţa, Argeş, determinări, calitate, degradare, Bucureşti, Budeşti.

1. INTRODUCTION

The river Dambovita is 286 km long and its basin has an area of 2.824 square kilometers, being the biggest tributary of the river Arges [13]. Its origin is in the Iezer-Papusa Mountains at an altitude of 1.800 meters, and its junction with Arges takes place near the city Budesti, at an altitude of 27 m [2]. The river's multiannual medium flow at the Lunguletu hydrometric station, situated upstream of Bucharest, is 9.95 cm/s, this value increasing until 1.91 cm/s at Plataresti, situated downstream of Bucharest, as a result of the share originated from the waters of Colentina and Pasarea, plus the overflows of urban wastewaters [2].

Until a few kilometers upstream of the Municipality of Bucharest, the Dambovita's riverbed is in its natural state, displaying a more emphasized meandering in the plain area. Downstream from Bucharest, the riverbed was rectified and sloped until the junction with Arges, while in the city it experienced an emphasized modification within the Complex equipment of the Dambovita river program, which took place from 1985 until 1989 [2]. As a result of the mentioned project, the Morii Lake accumulation, was created, located at the entrance of the river into the city, with a surface of 220 ha, a depth of 10 m, and a volume of water of about 20 millions cm at the normal level of retention, downstream of which the river drains through the vat of clean waters, divided into 11 water tails starting with Grozavesti and ending with Glina, underneath of which the box for collecting wastewaters was build, formed by two compartments that merge at a distance of about 1 km upstream from Glina, carrying the waters to the wastewater treatment plant [2].

2. METHODOLOGY

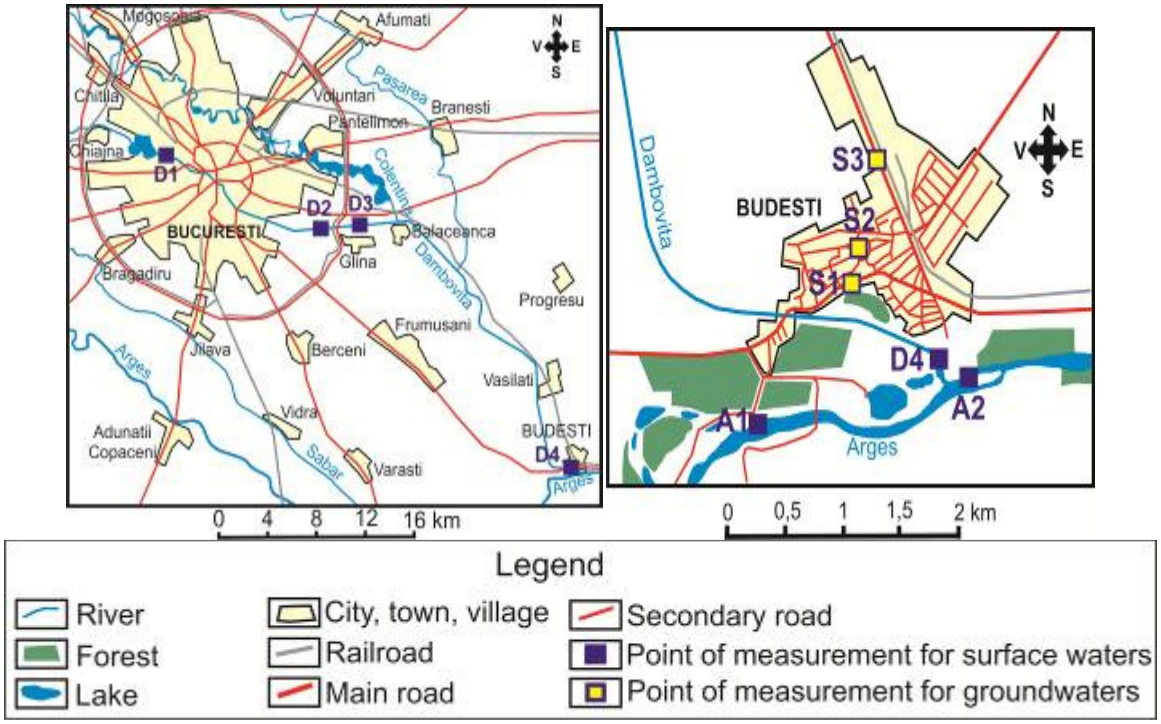
In order to realize this study, a series of determinations of the main physical and chemical surface water and ground water properties were made, using devices and kits produced by HANNA company from the Backpack Lab package. For the collected water samples the following properties were determined: the pH, electrical conductivity, total dissolved substances, turbidity, nitrates and phosphates concentration, oxygen and dissolved carbon dioxide concentration, as well as hardness.

The water samples were collected from certain points chosen to highlight how the surface water and ground water quality is influenced by sources of degradation concentrated in the Municipality of Bucharest area. In terms of surface water, for this study, the chosen rivers were Dambovita, which, being the receiver of waste untreated waters generated mainly by the domestic and industrial sources within the capital, is one of the most polluted watercourses in the country, and his collector, Arges, its quality being deteriorated by the waters of Dambovita.

For the first mentioned river determinations were made at four points marked as D1, D2, D3 and D4 from upstream to downstream (Figure no. 1). D1 was considered representative for the state of Dambovita at the entrance in Bucharest, because it is located 200 m downstream from the Morii Lake's dam, before any discharge of wastewater from the city. D2 and D3 are located at the output of the river from the urban area, the first one at 1,200 m upstream, and the second one at 200 m downstream from the point of overflow of untreated waters from Glina, which is in fact the most important point-like source of pollution within the researched region. The two points were chosen so as to indicate the changes of the river's water quality state because of the share of these wastewaters. D4 is located 200 m away from the junction of the river Dambovita with Arges, capturing the quality state of its waters that degrade the waters of the collector.

Figure 1: The measuring points on the Dambovita

Figure 2: The measuring points on river the river Arges and those on the ground waters



For the river Arges, determinations were made at two points marked A1 and A2 from upstream to downstream, the first one located at 1,700 m upstream, and the second one at 300 m downstream from the junction with Dambovita (Figure no. 2). The points were chosen to mark its waters degradation due to the share represented by Dambovita.

Regarding the ground waters, water samples were taken from three wells located in the Budesti city situated in an approximately straight line perpendicular on the general

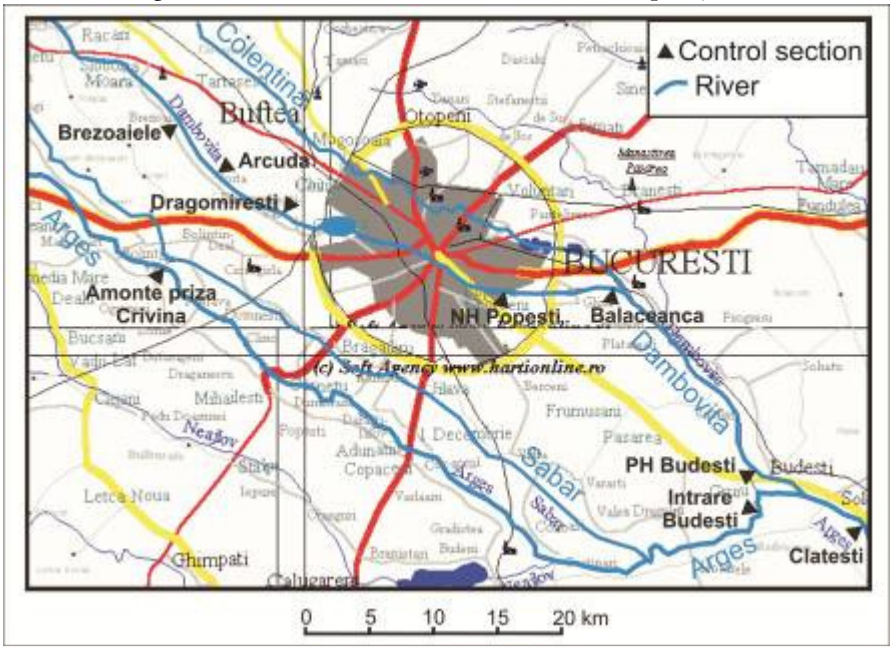
flow of Dambovita within the city's area (Figure no. 2). The points were marked as S1, S2 and S3, being chosen to indicate how the degraded water infiltrations from Dambovita influence the quality of the ground waters depending on the distance away from the river (S1 is located 300 m from the river, S2 is 500 m from the river, and S3 is 1,100 m from the river).

The determinations mentioned above were made on March 15 2011 for the D4, A1, A2, S1, S2 and S3 points and on March 17 for the D1, D2 and D3 points. It is worth mentioning that in these two days and the week before them, there was no rainfall recorded.

To compare the results of our determinations with those obtained within the national network for monitoring surface water quality, information regarding the fitting of water quality classes of Arges and Dambovita rivers extracted from the 2009 Report on the state of environmental factors in the Bucharest - Ilfov Region, were used.

Data regarding the water quality from the following monitoring sections were extracted: for Dambovita: Brezoaiele, Arcuda and Dragomiresti (upstream of Bucharest), Popesti, Balaceanca and Budesti (downstream of Bucharest), and for Arges: upstream of Crivina outlet and Budesti entry (upstream of the junction with Dambovita) and Clatesti (downstream of the junction) (Figure no. 3).

Figure 3: The location of water quality control sections on Arges and Dambovita in the Bucharest municipality area



Adapted by [10]

3. RESULTS

According to our personal determinations, the results for Dambovita, summarized in Figures 4, 5, 6, 7 and 8, a strong degradation of the river's water quality in the area of Bucharest is indicated, the main cause being the discharge of wastewaters from the Glina village area derived from the city and previously untreated.

More specific, those wastewaters collected in the city's sewerage network, represented by domestic waters (with a high content of organic substances, detergents, nitrogen and phosphorus compounds, phenols, and microorganisms), industrial waters (polluted with petroleum substances, acidic or alkaline substances, heavy metals, detergents, chlorides, sulfates, organic substances) and pluvial waters (these wash the impermeable surfaces of the city, enriching themselves with suspended organic and mineral substances, oils, detergents) [4] [5].

Due to the previously mentioned point-like pollution source, an acute change in the water properties is observed, determined with the help of personal measurements between points D2 and D3, in the sense that its quality is deteriorated. In general, there is a shortage of significant differences between parameter values measured at points D1 and D2, due to a shortage of degradation sources. Also, the water quality of Dambovita is slightly improved between D3 and D4 points, noticed in the case of the electrical conductivity, total dissolved substances, turbidity and dissolved oxygen properties, due to a share of waters of a better quality from the river Colentina and Pasarea stream, as well as the self-purification process.

In what follows, we will analyze the causes of changes in the physical and chemical water properties between points D2 and D3, a representative section for the water quality degradation process of Dambovita's waters in the Bucharest area. Regarding the pH (Figure no. 4), there is a high initial value, which classifies the river's waters in the category of alkaline ones, indicating a high content of carbonates [12], which is then reduced towards a slightly alkaline one, due to the contribution of waters containing acidic substances (hydrochloric acid, nitric, sulfuric, acetic acid), derived from industrial sources [3] [5].

Regarding the electrical conductivity (Figure no. 4), an increase of more than two times the values of the two points can be noticed , which indicates a sharp increase in concentration of salts dissolved in water, from industrial sources (mineral salts) and domestic (especially sodium chloride) [3]. Large increases can be also detected for the total dissolved substances indicator (Figure no. 5) (about two times), which is in agreement with the previous indicator, salts holding a significant share in the category of substances dissolved in water. The increasing trend is valid for turbidity (Figure no. 5), but with a much higher intensity (higher values of about eight times in point D3 than in D2), that leads

to an enrichment of the river's waters with suspensions of which the source is the industry (sand, metals, colloids) or the domestic activities (organic substances, microorganisms).

Figure 4: The pH and electrical conductivity

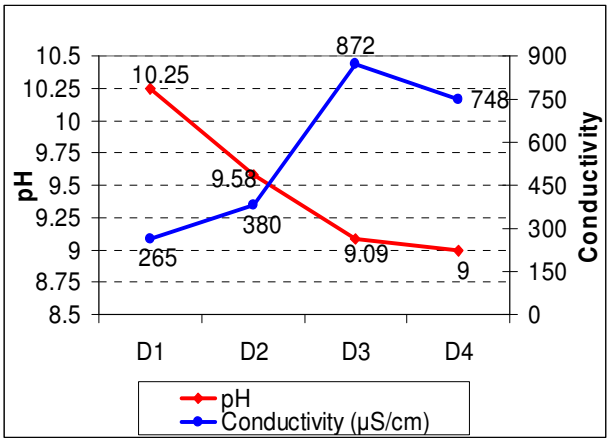
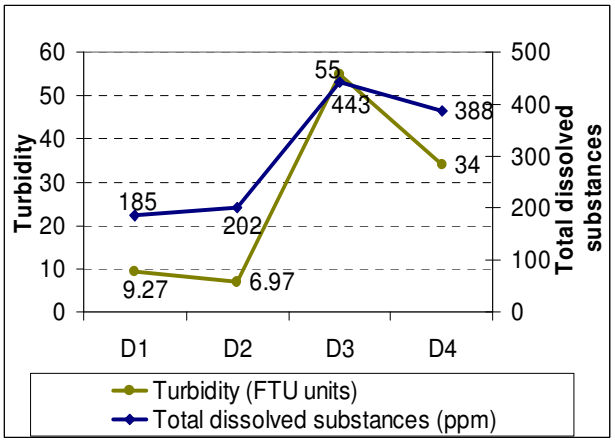


Figure 5: Turbidity and total dissolved substances



Regarding the nutrient concentrations in the water (Figure no. 6), increases between the two points for both nitrates and phosphates can be noticed, more pronounced, however, in the case of the latter, for which values are increased tenfold.

The increase of nitrate content in the water is mainly due to bacterial oxidation of organic matter, especially those of animal origin, derived from both industrial (especially food industry) but also domestic sources [12]. Taking into consideration the phosphates, the increases arise as a result of polyphosphate detergent and dejection uploads from the domestic wastewaters flowing into Dambovita [12].

Looking at the main dissolved gases from the surface waters, oxygen and carbon dioxide, respectively, an inverse trend is observed at the two parameter's values (Figure no. 7), the first one shows decreases (almost six times), and the second increases (more than twice) between the two points D2 and D3. The main causes for the decrease of oxygen are the oxidation of organic substances in the water (anaerobic fermentation of organic waste) and the processes of decomposition of proteins from domestic waters [12]. The increases found for carbon dioxide arise because of the fermentation of decomposed organic waste from the domestic waters, also due to the waters rich in this gas in this case as a result of industrial activities, such as the food industry [12].

Figure 6: Nitrates and phosphates

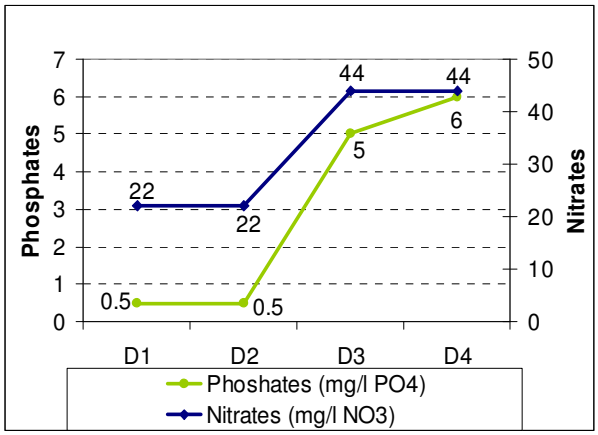
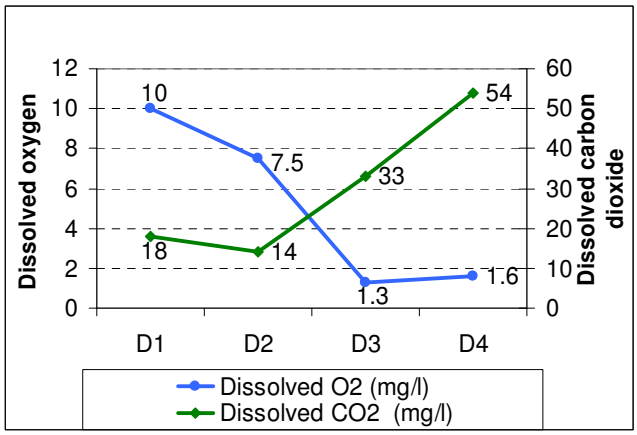
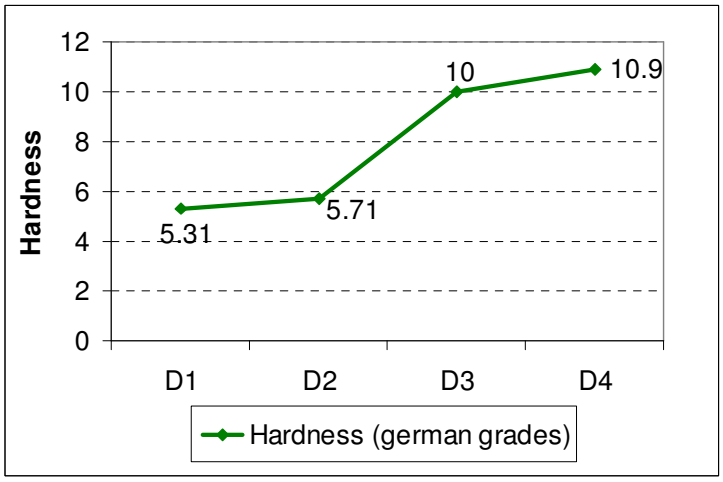


Figure 7: Dissolved oxygen and carbon dioxide



The hardness of Dambovita's waters doubles its value between the two points (Figure no. 8), the explanation consists in an increased concentration of calcium and magnesium salts in the water from both industrial and domestic sources, as well as the resulting colloid suspensions from the operation of power plants [3].

Figure 8: Hardness



Given that the dissolved oxygen is one of the most important indicators of water quality [7], we created a class classification of Dambovita for the four points used in this study (Table no. 1). A very sharp water degradation can be observed that moves from a very good state in D1 point to an unsatisfactory one in the points D3 and D4.

Table 1: Quality class classification of Dambovita waters in Bucharest municipality area

Measuring point	1	2	3	4
Quality class regarding dissolved oxygen		I		

According to the results of our determinations for the river Arges, summarized in Figures 9 and 10, it is considered that the degraded waters of Dambovita have a negative influence on its collector. Thus, increases in the values for turbidity, electrical conductivity, total dissolved substances, nutrients, hardness and dissolved carbon dioxide can be observed, as well as decreases in the case of pH and dissolved oxygen. These changes are explained by the intake of Dambovita waters that records exceeded values of the quality indicators in the category of oxygen, nutrients and organic micro pollutants [1]. Therefore, the water quality at the point A2 is lower than in A1, but higher than the D4 point, because of the river's flow greater than that of Dambovita, providing a more intense dilution of pollutants. Using, as in the previous case the dissolved oxygen indicator for determining water quality's class, we obtained the category II for the A1 point and the category V for the A2 point.

Figure no. 9: Results for determinations at A1 and A2 points (I)

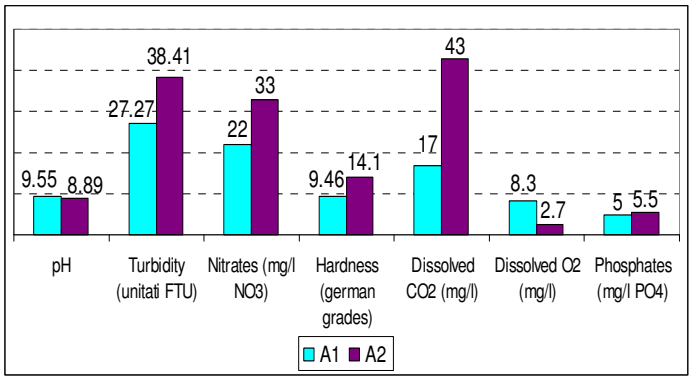
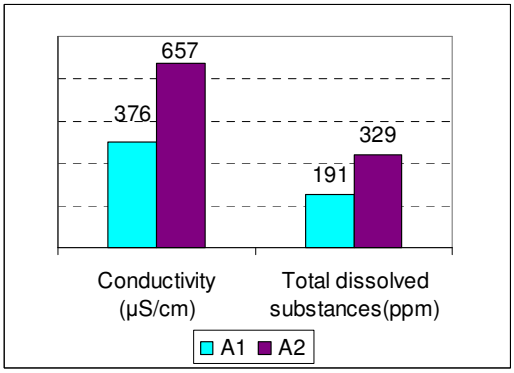


Figure no. 10: Results for determinations at A1 and A2 points (II)



According to the results of our measurements in the case of ground waters in the city Budeşti, it is considered that infiltration from Dambovita influence the groundwater's quality, detecting a slight degradation as the points of measurements approach the river (Figure no. 11 Figure No. 12). Thus, between the point S3, the most distant, and S1, the closest to Dambovita, a progressive increase in the indicators values for turbidity, conductivity, total dissolved hardness, nutrients and dissolved carbon dioxide and a

progressive decrease in pH and dissolved oxygen, can be noticed. However, due to the filtration that the water undergoes when passing through sand and gravel specific to this area, water samples collected from all three points fit the drinking limits, under the 458/2002 Law (Law on drinking water quality). Moreover, it is estimated that the infiltrations from Dambovita contaminate the groundwater, making the water unfit for human use, over a distance of about 100 m from the river [11]. The only problem posed is because of high hardness of the ground waters that exceeds 30 ° German at two points, which could be explained by the washing of clays present in the region's substrate in question [12]. It is worth mentioning that the city's residents of Budesti supply themselves with water derived from the centralized system, its origins being the deep ground waters at a distance of about 1.5 km from Dambovita.

Figure 11. Measurement result for S1, S2 and S3 points (I)

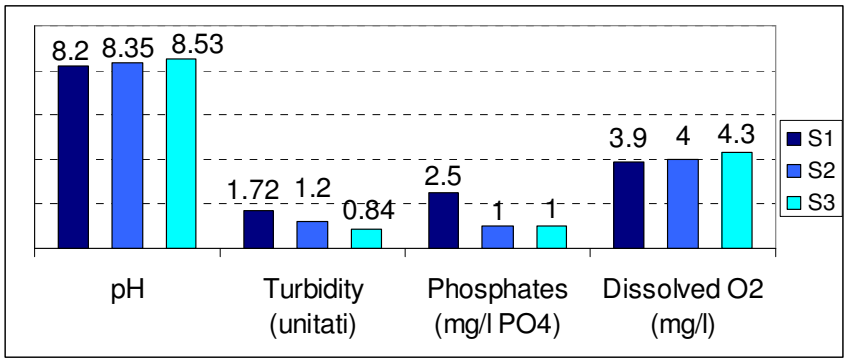
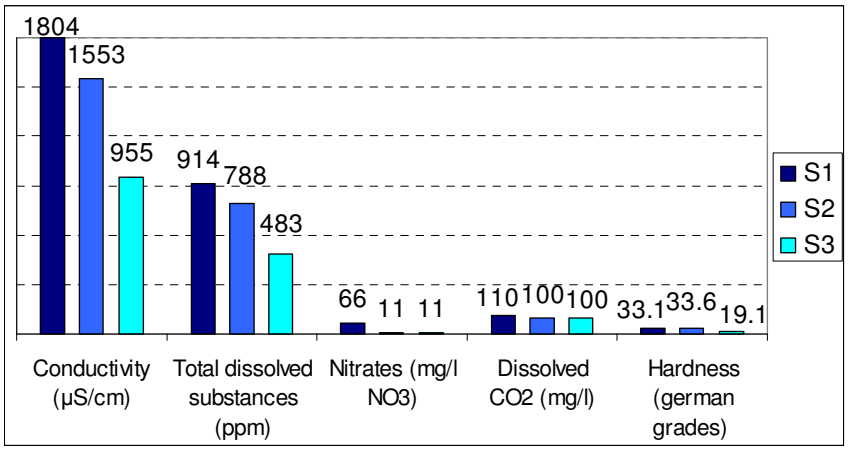


Figure 12. Measurement results for S1, S2 and S3 points (II)



According to the determinations made within the national network for monitoring surface water quality on Dambovita and Arges rivers in the Bucharest area [8], the results are summarized in Figure no. 13 and no. 14. Looking at the river Dambovita an oscillation of the water quality state stands out in the Brezoaiele - Popesti section, between class II and III, due to a diffuse nutrient pollution from agricultural sources [1]. In contrast, between the sections Popesti and Balaceanca, section in which the discharge of untreated wastewaters from Glina takes place, there is a strong degradation of the quality status, waters becoming classified in the class V, because of registered overruns of the oxygen regime, nutrients and organic micro pollutants indicators, a situation that remains the same until the junction with Arges [1]. In the latter case, the degraded waters of Dambovita cause the decrease of water quality between the points located upstream (II quality class) and downstream (IV quality class) of the two river's junction. Therefore, the results obtained from water quality monitoring within the national network are consistent with those extracted from our own determinations.

Figure 13. The evolution of Dambovita's water Bucharest municipality in 2009

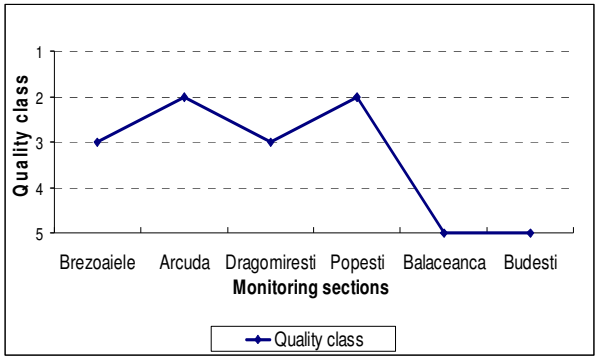
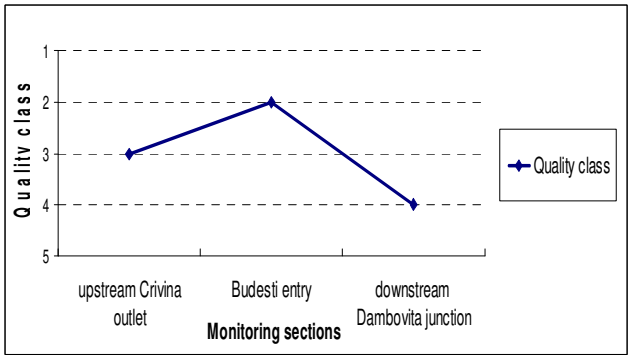


Figure 14. The evolution of Arges' quality in the are water quality before and after the junction with Dambovita in 2009



4. DISCUSSION

From the foregoing, a sharp deterioration of the water quality of Dambovita is considered to be located between the upstream and downstream of Bucharest. Concentrated sources of degradation in this region are represented mainly by the industrial and domestic ones. Domestic sources are responsible for enriching water with organic substances, nitrogen and phosphorus compounds, detergents, phenols and microorganisms [4, 5]. Industrial sources are the most important when it comes to water degradation , being responsible for the emergence of special toxic compounds [5]. Of these, the industrial

activities that use hazardous substances in the production process have the biggest impact [5]. For Bucharest, the industry units that stand out are:

- energy (that enrich the water with petroleum products, suspensions, detergents, acids, sulfates) [3], as Grozavesti CET, Progresul CET, South CET and West CET
- ferrous metallurgy (cyanide, substances with acidic and basic, heavy metals) [3], as Doosan IMGB;
- machine building (cyanides, chromates, various acids and bases) [5], as Turbomecanica, SC Urbis SA Sanitary Fittings, Grivita workshops;
- chemical (dyes, sulfuric acid, nitric, acetic, hydrochloric, different bases) [3], as Policolor, SC Prodplast SA, Rodmir Wizard LLC;
- building materials (mineral suspensions) [3], as Western Precast, Stirom SA;

Most of these industrial units have their own treatment plants, which have, however, technically outdated and ancient equipment (Dudesti industrial area - Policolor, 40 years, the industrial area of Military, over 30 years, in some cases even 70 years)[6].

Both domestic and industrial wastewaters are collected by the sewerage network of Bucharest, composed of about 2300 km of canals and collectors [2]. All these waters, plus the pluvial ones, end up in the wastewater box below Dambovita, which leads them to the Glina wastewater treatment plant. The latter is situated in the south - east of Bucharest, on the right bank of Dambovita, in the administrative territory of the village with the same name. In March 2011, the average flow of wastewaters returned to the river is between 13 and 13.5 cm/s [9]. Although the building of the station began in the mid 1980s, it has only partially worked for several months in 1996. In November 2010 the works at one of the two lines at which the station was designed to operate were completed [9]. Until April 2011, the station had not functioned as a series of tests to facilities in its composition were carried out. According to official statements [9], starting with the mentioned month, line one will operate at the designed parameters. This means the mechanical treatment of 10 cm/s of total flow that enters the station, 5 cm/s will be purified biologically and tertiary (phosphorus removal). Line two, which will ensure the complete purifying of the entire flow to enter the plant will be built in the period 2012-2015.

5. CONCLUSIONS

As a result of our personal measurements, confirmed by the measurements performed within the national system for monitoring surface water quality, we draw the following conclusions:

- The water quality of Dambovita changes from class II of quality upstream of Bucharest to class V of quality downstream of Glina, due to overruns recorded in the following groups of

indicators: oxygen regime, nutrients and organic micro pollutants;

- Arges's waters pass from class II of quality to class IV after the junction with Dambovita, due to the overruns discovered in the nutrients group;
- Budeşti's underground waters are altered by infiltrations from Dâmbvoiţa progressively as the distance from it decreases;

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