STUDIA UBB AMBIENTUM, LX, 1-2, 2015, pp. 117-127
(RECOMMENDED CITATION)

SURFACE WATER QUALITY. STUDY CASE: RIVER GALDA, ALBA COUNTY, ROMANIA

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ABSTRACT. Pollution is affecting all of the water characteristics, and generate degradation of physical, chemical and biological parameters. A strong pollution phenomena can lead to ecological disruption, or destruction of aquatic flora and fauna. To avoid complete destruction of the hydrosphere is necessary to adopt pollution prevention and cessation. This study is a water quality assessment on river Galda from Alba County. Water quality assessment was done by analyzing the physicochemical parameters of water and by analyzing the existing benthic community in the rivers waters. These parameters are relevant to assess the rivers pollution and its variation over time. Study results revealed a proportional increase of pollution with the number of inhabitants in the river area. A major influence on river Galda water quality is the agricultural and farming land near the river, also industrial activity, which generate in about 10 years, a significant degradation of environmental quality.

Key words: *surface waters pollution, water quality assessment, ecological status, diatoms*

INTRODUCTION

Water has become a resource irreplaceable as a result of the demographic explosion in the recent decades, along with the society demand of water for maintaining a high level of quality of life and to ensure socio-economic development. This has generated a true ecological crisis (Falkenmanrk and Biswas, 1995). Because of the various water use in human society, in water reach different pollutants and then this wastewaters are discharged into surface waters, particularly rivers. All those stress factors generate a strong process of degradation, manifested by altering the physical, chemical and biological quality of rivers water, with adverse consequences for human health and the environment. (Truța, 2013).

The quantifying the pollution of a river is achieved through quality assessment. By monitoring the water quality parameters it can determine the degree that river was affected by pollution and can design a method of prevention or diminishing the phenomenon of pollution (Ludwig and Storrs, 1973).

The river considered in this study is the river Galda, a medium size river from Alba County, strongly affected by the pollution from anthropogenic sources. To restore ecological balance in this area is necessary to monitor water quality parameters and evolution of pollution gradient, from the source of the river to his confluence with river Mureș.

The case study was to determine the physical and chemical parameters, represented by the oxygen regime, nutrients, salinity, temperature, acidification, toxic pollutants of natural origin, hydro-biological parameters represented by phytobenthos and the viruses and bacteria contained in water for microbiological parameters to show the influence on human settlement and activity related on surface waters.

This study consisted on monitoring the river for one year, with sampling period of 3 months: November, February and May. The results will reflect the specific meteorological and hydrological conditions of that period.

River studied is Galda River, located in Alba County. River springs from Negrileasa Mogosului, at an altitude of 1364 m, located in Trascau Mountains. The river has a length of 39 km and his entire basin is an area of 253 km^2 (Hanciu, 2003).

This river was chosen because the numerous settlements and factories in the food industry formed along his course. In appearance, this anthropogenic formations on river banks have a strong impact on water quality due to the wastewaters discharged straight into the river, or due to the numerous wastes deposited on the riverbanks or spills of toxic substances such as chemicals used in agriculture.

MATERIALS AND METHODS

Characterization of rivers waters in term of quality investigation was conducted using data from four control sections on the river Galda. The first sector is the “control sector”, which includes the upper river and its source. The second area is the middle course of the river crossing localities with population more than 200 people, and in this section was also build an abattoir. The third section is the lower course of the river that cross localities with a population about 1 800 inhabitants and also this section is downstream from two food factory. The fourth section, and the last is the lower course of the river and crosses a locality with more than 2 800 inhabitants, this section include another food factory. Section aim to highlight critical points regarding water quality as is shown in figure 1.

Sampling

Water sampling was done according to STAS 6324, to ensure that the samples are representative, thus eliminating the possibility of errors in the analysis.

Sampling for analysis of physical and chemical parameters is performed in sterile polyethylene bottles with a capacity of 2 liters fitted with a stopper.

Taking water samples for analysis of phytobenthos, and microbiological parameters is done in glass recipients, sterile, hermetically sealed. In order to achieve phytobenthos analysis, samples were collected by scraping the substrate immersed in the river for at least 4 weeks. Handling and preparation of samples is performed according to PGL-13.

The physical and chemical analyses of water in the study were: thermal regime and acidification, oxygen, nutrients, salinity, toxic substances of natural origin. Other physical and chemical parameters analyzed are: turbidity, color, odor, total solutes, conductivity, total alkalinity, total acidity and total hardness of water.

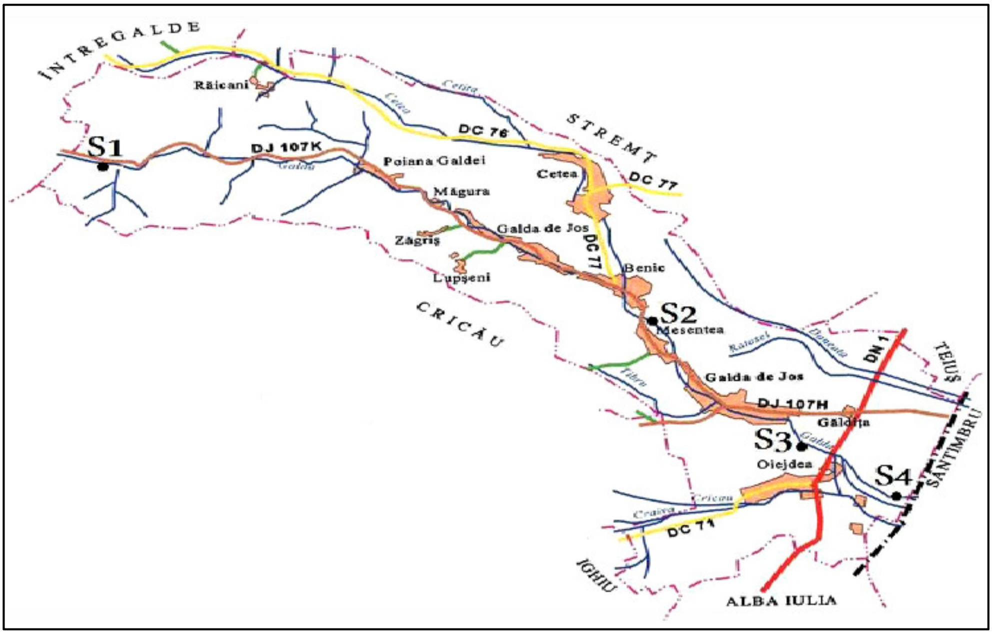

Fig. 1. Study area and sampling points

These determinations were made by potentiometric methods, analytical and instrumental methods, analytical and instrumental methods and volumetric methods. Setting the class of chemical quality of water is done using worst scenario.

In site where determinants water temperature using and electronic thermometer stem, also, color and odor of water were determinates organoleptic.

The oxygen class parameters: Dissolved Oxygen (DO), Biochemical oxygen demand at five days (BOD5) where determinants in laboratory using the Winckler method, and Chemical Oxygen Demand (COD) has been determined by titration with potassium permanganate.

Nutrients class parameters where determined by spectrophotometric methods to achieve analysis using Spectroquant Nova 60 (SQ) Specific Kits.

Salinity class parameters were determined by complexometric titration using complexone Ethylenediaminetetraacetic acid (EDTA III) 0,01 M and Murexid. Using the volumetric titration with EDTA III complexone was determinated water hardness. Acidity and alkalinity of the water was determined by titration with NaOH 0,1 N and HCl 0,1 N.

Heavy metals were determined by X-Ray Fluorescence Spectrometry using EDXRF Quand'X ARL Spectrophotometer.

Assessment of the ecological status of the river Galda was achieved by Pantle-Buck Method. Phytobenthos study was performed using a microscope Optec B.03 at 1000X magnification. The analysis consisted of identifying and counting species prevalent category of benthic algae using saprobic system developed by Marsson Kolkwitz.

Analysis of microbiological parameters was performed by standardized and approved methods. Determination of the total number of bacteria was done according to SR EN ISO 6222/2004. Detection and enumeration of Escherichia E.coli and Coliform Bacteria was performed according to EN ISO 9308-1/2004, SR EN ISO 788-2/2002. Identification and enumeration of Enterococci was performed by membrane filtration method according to SR ISO 21528-1/2 2004.

By applying these methods of analysis, were obtained some results that were interpreted under the laws, by comparing the value obtained with the limit value allowed by national and international law.

For the classification of water in quality classes according to the value of physical and chemical parameters were used as quality classes and limit values shown in Table 1.

Table 1. Maximum limits and quality class for physical and chemical parameters

Quality parameter	U.M	Quality class				
		I	II	III	IV	V
Thermal and acidification						
Temperature	°C	not standardized				
pH		6.5-8.5				
Oxygen						
DO	mg O_2/l	12-14	10-9	5-4	5-1	0
BOD_5	mg O_2/l	3	5	7	29	20.01
COD-Mn	mg O_2/l	5	10	20	50	50.01
Nutrients						
Ammonium	mg N/l	0.4	0.8	1.2	3.2	3.201
Nitrite	mg N/l	0.01	0.03	0.06	0.3	0.301
Nitrate	mg N/l	1	3	5.6	11,2	11.20
Salinity						
Calcium	mg/l	50	100	200	300	300.1
Magnesium	mg/l	12	50	100	200	200.1
Toxic pollutants						
Zinc	µg/l	100	200	500	1000	1000.1
Iron	µg/l	0.3	0.5	1	2	2.01
Copper	µg/l	20	30	50	100	100.1
Other Physical parameters						
Conductivity	µS/cm	<1000				>2500

Framing saprobic and ecological status assessment is performed using Pantle-Buck method, illustrated in Table 2.

Table 2. Pantle-Buck method for establish ecological status

Saprobic index	Saprobic zone	Contamination	Quality status	Ecological status
1,8	o o-b	contamination absence low	I	Very good
2,3	b	moderate	II	Good
2,7	o-a	moderate to critical	III	Stisfy
3,2	a	strong	IV	Moderate
>3,3	a-p p	strong to very strong strong	V	Very bad

NOTE: *) o= oligosaprobic; o-b= oligo-beta-mesosaprobic; b= beta-mezosaprobic; o-a= oligo-alpha saprobic; a= alpha-mezosaprobic; a-p= alpha-polisaprobic; p= polisaprobic

The saprobic is calculated with the ecuation (1):

$$S = \frac{\Sigma(si*hi)}{\Sigma h} \qquad (1)$$

where:

s= caracteristic value belonging to saprobic zone;
h= absolute frequency of species;
i= taxa;
∑ (si*hi)- the amound product of the frequency and numeric value for each taxa;
∑h= absolute frequencies of the amount of taxa.

In terms of microbiological parameters analyzed values are relate to the Directive 76/160/EEC as river water taken in the study is classified as bathing water. According to this Directive in Table 3 are the maximum allowable concentrations for the parameters analyzed.

Table 3. Maximum allowable concentration for microbiological parameters

Coliforms bacteria/ 100 ml	Escherichia E.coli / 100 ml	Enterococci/ 100 ml	NTG/ ml
500	100	100	>500

RESULTS AND DISCUSSIONS

By applying the methods laid were determined main relevant parameters for assess the ecological status and the water quality for river Galda. After the analysis of all parameters, the water was classified in an appropriate quality class for each sector in the study.

In the figure 2 and figure 3 we may see that in terms of physical parameters the water is slightly basic due to the presence of carbonates and bicarbonates in the limestone substrate of the riverbed.

We can observe weather conditions specific to each period. Thus in May, due to higher flow rates were measured higher values for each parameter.

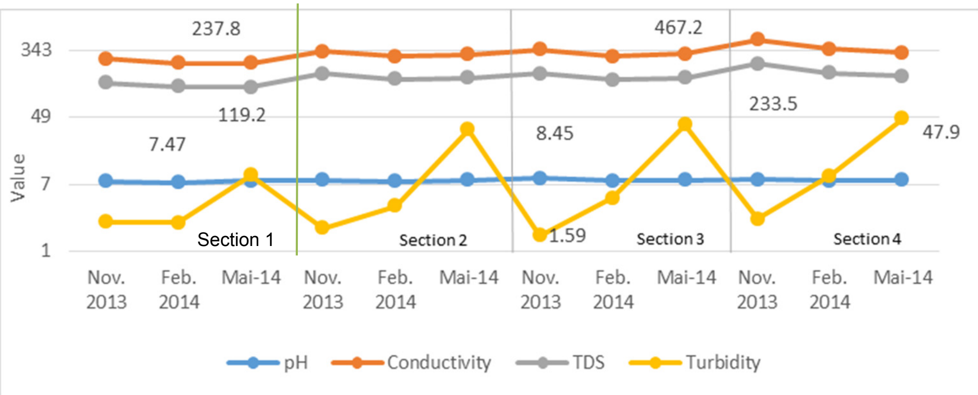

Fig. 2. *Physical parameters for river Galda*

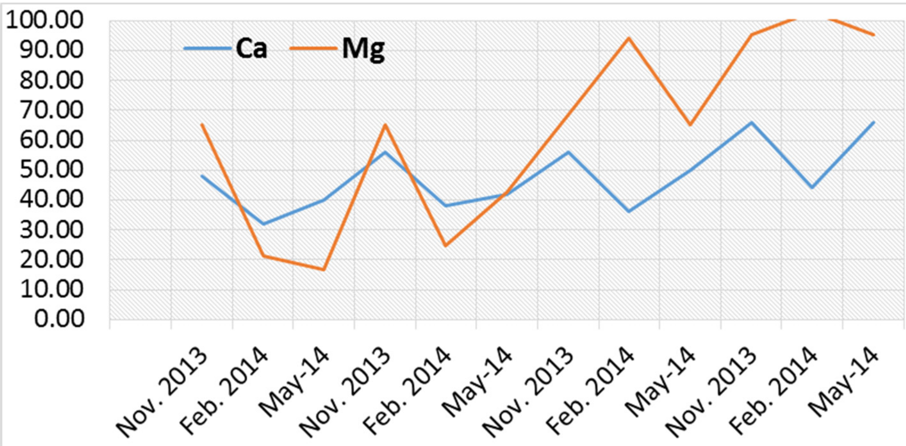

Fig. 3. Anions content

As we can see in the figure 4, the regime of nutrients parameters have higher values in the lower sections of the river in May, due to the expansion of the land in the riverside and the floodplains. These sections are prone to nutrient pollution from agricultural sources due to excessive use of chemical fertilizers.

Those sections are included in the National Plan on the Protection of Waters against Pollution caused by nutrients from agricultural source, in accordance with Directive 91/676/EEC, due to high level of nitrates concentration in water and soil.

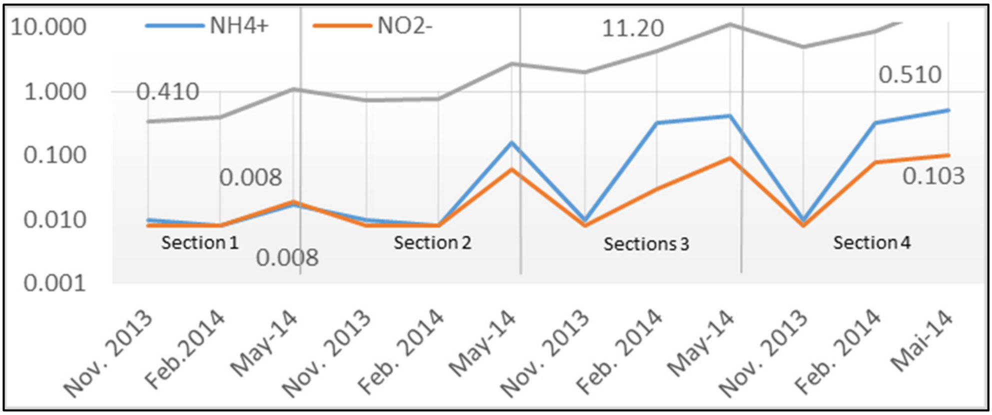

Fig. 4. *Nutrients regime for river Galda*

The concentration of heavy metals identified are represented in figure 5. The values for November and May are higher due to flooding the lowlands and due to runoff water. In Section 3 in November Zn concertation is higher than normal. This anomaly is due to wastewater spill from one of the factories in the area. This wastewater contains white sediment that caused an increase of water turbidity and also the Zinc level.

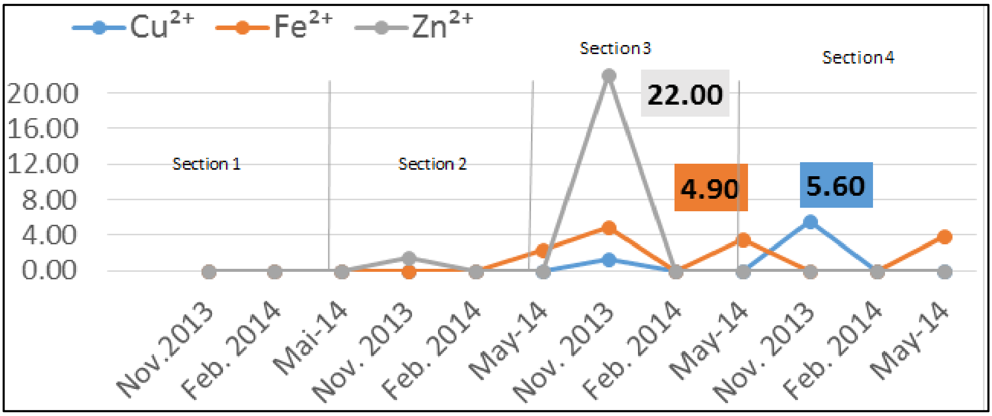

Fig. 5. Toxic pollutants- Heavy metals

The oxygen regime parameters are strictly correlated with the content of biological material in water as it may be observed in the figure 6.

The degree of oxygenation of water is strictly dependent on the content of organic material, thus CBO_5 demand and chemical oxygen demand (CCO).

After analyzing the samples from the perspective of the oxygen regime parameters was confirmed this dependence. Especially in highly polluted sections, like Section 3 and Section 4 where organic load is high, we can observe a degree of very low oxygen saturation that is threating the aquatic ecosystems in that area.

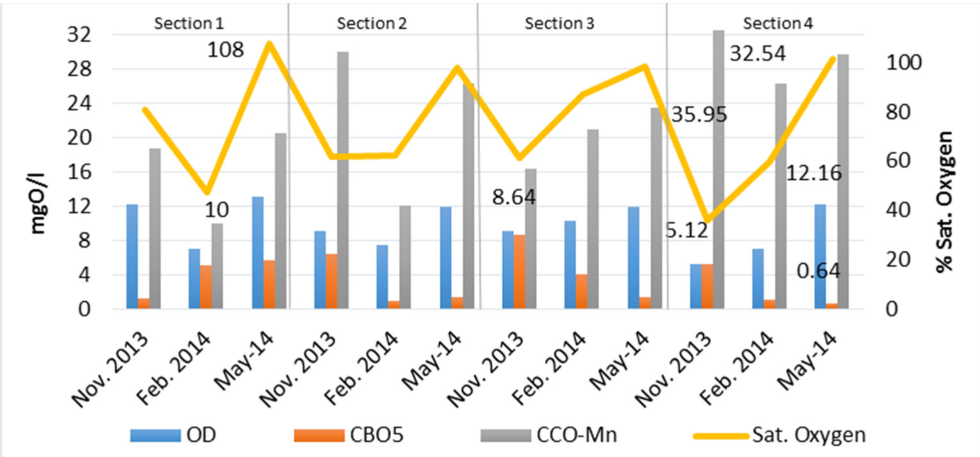

Fig. 6. *Oxygen Regime Parameters*

From the point of view of ecological status of water in each control section, it was analyzed the existing phytobenthos. Diatom communities identified fall into the category of Oligosaprobe in Section 1 which indicate a low level, near 0, organic contamination. As we can see in figure 7, the contamination with organic matter worsens as the number of anthropogenic activities performed on riverbanks increase.

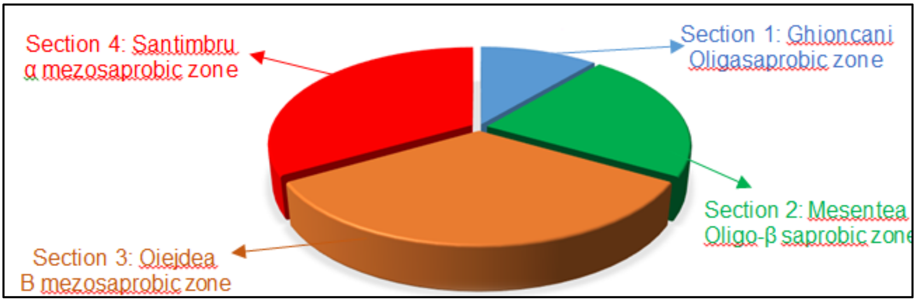

Fig. 7. *Saprobic zone on river's Galda control sections*

In control section 4 of river Galda exists a high impurity level of water due to wastes thrown in the water. Those results combined with oxygen regime parameters, bring out a critical contamination of water. Therefore the degree of oxygen saturation drops seriously and this affect flora and fauna in this section by preventing the photosynthesis process and gases transfer between water and air. The third and fourth control sections have a sharp eutrophication banks due to high organic impurification.

From the perspective of public health in the study area, were analyzed the content of germs and viruses pathogens. The results presented in figure 8, reveal that in the lower sections of the river, water quality is highly degraded by the pollution with waste containing faces.

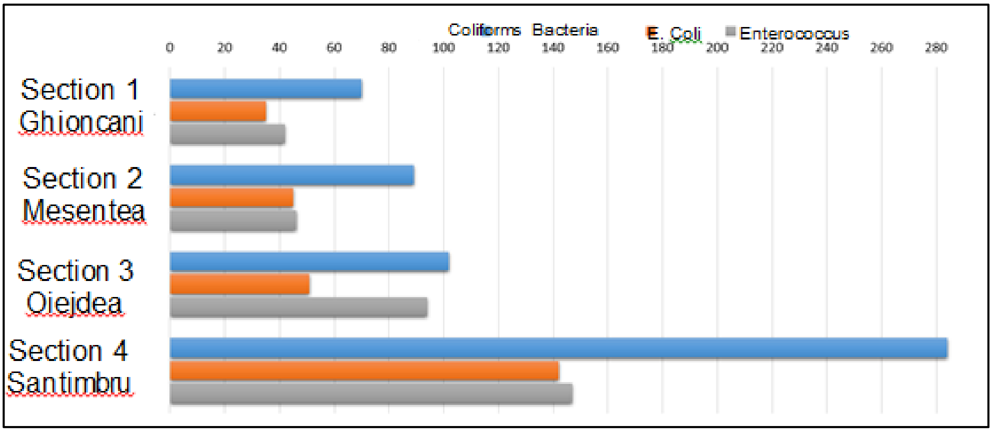

Fig. 8. Microbiological parameters

By consuming this insanitary water, population can achieve serious diseases. Also by consuming animal products, like milk or meat from animals who drink this water, the population can get many diseases like enterocolitis, diarrhea, gastroenteritis, etc. (Popa et all, 2015).

CONCLUSIONS

It was found the pollution is not accidental, but permanent and more serious as we move away from the river source as is shown in figure 9. The most polluted area are the Section 3 and 4, located in the lower reaches of the river. In those areas the pollution is due to the raised number of population and to the numerous factories from the food industry field (Truta, 2014). To reduce pollution in this area is necessary to inform the population, and especially to educate them for sustainable development, to learn how to preserve the environment in the best condition possible.

After completion of all analyzes could achieve integration of each control section in related quality class and establish the ecological status.

Analysis of the quality of aquatic systems has proved to be absolutely necessary for both human and for the smooth running of processes in the natural environment.

Following the survey we concluded:

- Surface water pollution is a serious problem and we have to apply remedial actions, for change the water status from qualitatively weak;
- River Galda face with organic pollution due to agricultural activity carried out in the area, but also because manure and wastewaters from food factories;
- From the river's source to his confluence with Mures, we can observe that the increasing number of residents is reflected in the environment by increasing the number of waste that end up in the river bed;
- In the lower areas of the river, oxygen regime parameters proved to be quite poor because of high organic matter reached into the water. This can lead to disruption of the entire aquatic ecosystem, or cause the extinction of some fish species;

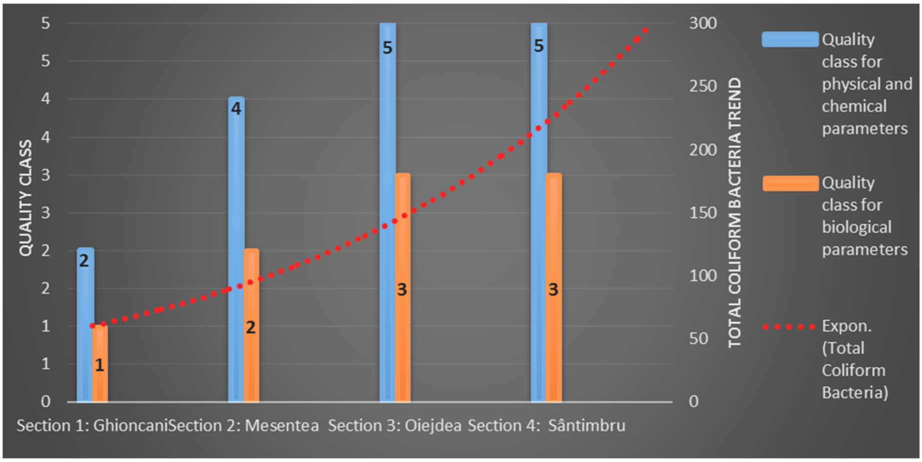

Fig. 9. Quality classes of River Galda

- Ecological status of the river is heavily degraded by the anthropic activity, as it can be observed in figure 10;

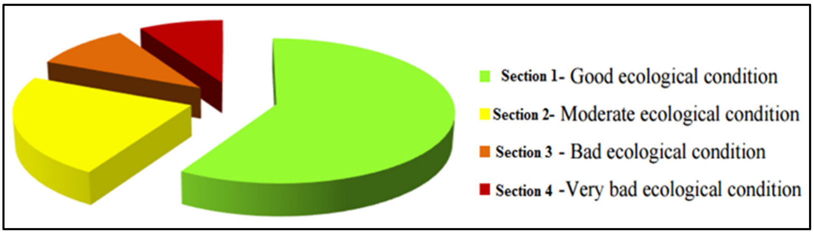

Fig. 10. Ecological status of River Galda

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