WATER QUALITY MANAGEMENT ON THE BEGA RIVER

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Abstract. *Efficient management of water resources aims to improve water quality and balance. This desideratum can be achieved by: equipping pollution sources with treatment plants and ensuring their operation, restoring degraded water courses to the economic circuit and their proper exploitation, applying the legislation in force on water quality protection, optimizing the location of polluting objectives in relation to the capacity of rivers to receive wastewater, creating protection zones especially in mountain areas and on upper water courses. Unfortunately, water sources are increasingly subject to pollution and treatment costs are increasing. To this, there was also added the global trend of reducing water resources, a phenomenon exacerbated by the prolonged drought of recent years. Moreover, these resources are subject to wide variations in time and space, making the management of these water resources increasingly difficult to manage. The present paper aims to study the degree of pollution of the Bega River, one of the most important watercourses of Banat, to highlight the sources of pollution that degrade the quality of this river and the consequences of degradation, and based on the resulting conclusions to outline the opportunities that lead to avoiding pollution and maintaining the natural balance characteristic of the aquatic environment. On the Bega River, 2 natural surface water bodies, 1 heavily modified water body and 1 artificial water body were monitored (according to the Banat Water Basin Administration) and the water quality was in good status at all of them.*

***Keywords**: water balance, water quality, water body, volume discharged, volume captured*

INTRODUCTION

Water management is the activity of planning, developing, distributing and optimally using water resources, within a defined regulatory framework. Water management may include: management of water treatment for drinking purposes, treatment of industrial or domestic wastewater, management of water resources (surface, depth), flood protection, water used for irrigation, etc (KRENKEL, 2012).

Currently, the recommended approach is integrated water management which "is a process of promoting the coordinated development and management of water, land and associated resources to maximise economic and social well-being without compromising the sustainability of vital ecosystems".

Depending on the strategy adopted by each country, water management priorities are established, which should include sustainable use of water resources, protection of the quantity and quality of water resources, priority of ensuring drinking water for the population, in the right quantity and quality, at a fair price (ECKENFELDER, 1980).

The European water regulatory framework includes several directives, among which we mention the Water Framework Directive 2000/60/EC, transposed into Romanian legislation by Water Law 107/1996, with subsequent amendments and completions (last updated in 2021). Training Package on EU Water Legislation – Environment – European Commission (europa.eu).

An important aspect to consider in water resources management is water pollution, which is any change in the composition or quality of water, as a result of human activities or natural processes, so that it becomes less suitable for its uses (HUANG, 2001).

Pollution of a surface water course means degradation of its physical, chemical or biological characteristics, caused directly or indirectly by human activities or natural processes, thus rendering it unsuitable for different uses (ONGLEY, 2000).

On a large scale, the degradation of natural waters began with industrialization and intense urbanization, imposing in time the need to preserve and protect nature from this danger (ȘMULEAC et all, 2022). Industry uses very large quantities of water, which is discharged in the form of water loaded with various products, generally unfit for life; Such water is wastewater, wastewater (ASANO, 1998). Water pollution has serious consequences because it jeopardises the supply of drinking water, makes water treatment plants more expensive and therefore the price of water, affects human and animal health, disturbs the natural biological balance of water (PERRY, 2009).

MATERIAL AND METHODS

The Bega River has a total basin area of 2,241 km^2, of which 2,211km^2 are on the territory of Romania (Timiş County). The length of the Bega River is 170 km, of which 168.6 km on the territory of Romania (Timis County), the remaining 1.4 km on the territory of the Republic of Serbia and springs from the western slopes of the Poiana Rusca Mountains, below the Pades peak, at an altitude of 1,150 m. The upper sector of the Bega River has two headwaters: Bega Poieni and Bega Luncani. The last one listed, Beghei proper, has its sources upstream of Luncani and flows north to Curtea where it has a confluence with the second branch. From the side of Margina, the upper corridor of the Bega River flowing southwest to the confluence with the Timiş-Bega supply channel, from Coştei locality (designed by the Dutch engineer Maximilian Fremaut in 1970, for the water supply of the Bega canal in Timiş, during deficient periods, with the design of the Bega River discharge channel into the Timiş River, is clearly outlined, between Topolovăţ and Hitiaş).

From its sources to this confluence, the Bega River is a natural stream (figure 1).

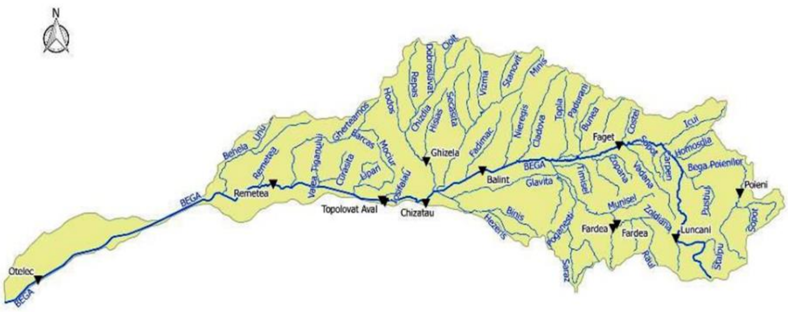

Figure 1. Bega River Basin

At the beginning of the twentieth century, in order to ensure a proper depth of navigation and reduce water speed, a series of locks and a hydroelectric plant were built (1909), with an installed power of 1,200 KW and flow of 36 m^3/s. Of the 7 locks built, 3 are on Romanian territory: Timisoara, Sânmihaiul Român and Sânmartinul German, and 4 on the territory of the Republic of Serbia: Srpski Itebej, Klek, Ecska and Titel (Table 1).

Table 1

Weirs on the course of the Bega River

No	Locality	Distance from mouth (km)	Level difference between biefs (m)	Dam height (m)
1	U.H.E. Timişoara	118,360	5.60	5.60
2	Sânmihaiul Român	103,800	2.40	3.50
3	German Sânmartin	88,800	2.80	6.25
4	Srpski Itebej	73,900	2.50	5.43
5	Klek	45,800	2.40	4.93
6	Ecska	18,800	2.00	5.68
7	Titel	2,000	-	4.50

In the hydrographic basin of the Bega River, runoff differs depending on relief and climatic conditions. In the high areas (Poiana Rusca Mountains**) the specific runoff** (q) has values higher than 40 l / s km^2, reaches values of 10 – 20 l/s km^2 in hilly areas, 2 – 5 l/s km^2 in the piedmont hills area and 1 – 2 l / s km^2 in the plain area.

Maximum runoff is influenced by climatic conditions and relief. Depending on the Hm/VF parameter, the specific flow rate with 1% insurance has values between 350 – 1,350 l/s km^2.

The minimum runoff is dependent on the degree of moisture of the bank (expressing this degree by specific flows, multiannual averages q), which can be highlighted by unitary areas from a physical-geographical point of view, correlated between the minimum flows specific to the multiannual average.

On the Bega River, 2 natural surface water bodies, 1 heavily modified water body and 1 artificial water body were monitored (according to the Banat Water Basin Administration):

- The RW5.1_B1 water body (BEGA - spring-cf. Bega Poienilor + tributaries) with a length of 115.94 km, having the type RO01, is characterized by the section Am.loc.Luncanii de Jos, EIONET type and Tomeşti drinking socket;
- The water body RW5.1_B2 (BEGA - cf. Bega Poienilor-cf. Chizdia) with a length of 58.84 km, with RO10 typology, is characterized by the Loc. Balint section;
- The water body RW5.1_B3 (BEGA - cf. Chizdia-cf. Behela) with a length of 43.78 km, having the RO11 typology, was characterized by the Am.loc section. Timisoara;
- Water body RW5.1_B4 (BEGA - cf. Behela-border), artificial water body, with a length of 44.71 km, type RO11, characterized by the section Locality Otelec, type EIONET and TNMN.

RESULTS AND DISCUSSIONS

For the Bega River, the specific minimum flows have values of 1 – 2 l/s km^2 on the upper course, 0.3 – 1 l/s km^2 on the middle course and less than 0.3 l/s km^2 on the lower course.

In the current regime, arranged, the average multiannual stock increases to approx. 16 m^3/s (with water derived from the Timiş River through the Timiş-Bega derivation)

The easement flow (in the area of Timisoara) is 2.1 m^3/s, and in the Otelec section, variable depending on the season (2.1 m ^{3}/s in summer and 2.7 m^3/s in winter), regulated by the border agreements in force, established by the Romanian-Serbian Hydrotechnical Agreements on water regime.

The maximum flow on the Bega River in the Timişoara area, modified by the hydrotechnical works upstream, is 83.5 m^3/s, as well as in the Otelec section, flow also established by the Romanian-Serbian Hydrotechnical Agreements on water regime.

As can be seen from Table 2, these maximum permissible flow rates have not been exceeded. This is due to the Topolovăţ-Hitiaş canal that discharged into the Timis River basin, the excess waters of the Bega River, upstream of Timişoara (Balinţ area).

Table 2

Characteristic flows of the Bega River in 2015-2020

2015					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,510	1,350	1,620	0,772	15,100
Balint	1,200	6,280	6,280	1,830	88,900
Remetea	5,040	22,200	11,900	6,980	24,500
2016					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,510	1,350	1,620	0.570 / 6-15 VIII	5,950 / 24 XII
Balint	1,270	7,100	9,120	1,590 / 28 VII	94,000 / 24 XII
Remetea	5,040	20,000	13,400	10,100/04 VI	31,900 / 24 XII
2017					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,480	1,350	1,890	1,15 / 31 III	10,100 / 13 X
Balint	1,270	6,850	10,600	2,66 / VIII 05	111,000 / 23IV
Remetea	5,040	16,000	16,800	12.9 / 04 II	30,600 / 24 IV
2018					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,480	1,350	1,460	0.750/III, IV	14,200 / 21 IV

Balint	1,270	6,850	7,160	2,260/VII, IX	96,000 / 07 I
Remetea	8,000	16,000	16,600	11,900/VI, VIII, IX	26,000 / 07 I
2019					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,480	1,350	1,840	0.712 / 14 XI	15,900 / 22 II
Balint	1,270	6,850	11,500	2,140 / 22 X	242,000 / 23 II
Remetea	8,000	16,000	17,000	12,900 / 04 X	66,600 / 24 II
2020					
Control section	Calculation flow rates m^3/s		Recorded flow rates m^3/s		
	95%	Multi-annual environment	medium	minimum	maximum
Luncani	0,480	1,350	1,700	0.555 / 16 X	98,000/06 IV
Balint	1,270	6,850	78,300	1,690 / 29 VIII	232,000 / 6-7 IV
Remetea	8,000	16,000	13,200	7,620 / 10-12 XII	35,800/07 IV

Assessment of the status of water bodies in 2015

The RW5.1_B1 water body (BEGA - spring-cf. Bega Poienilor + tributaries) From the point of view of biological elements, the water body was in good ecological status. The biological elements evaluated were Phyto benthos and benthic invertebrates in very good ecological status, fish classified in good ecological status.

From the point of view of general physicochemical elements, the water body fell into the moderate state, due to the indicators related to the group oxygenation conditions and nutrients.

In terms of specific pollutants, the water body was in good condition.

The water body was in good ecological status, the physicochemical elements took into account statistical quantities at 75 %.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B2 (BEGA - cf. Bega Poienilor-cf. Chizdia)From the point of view of biological elements, the water body was in good ecological status. The biological elements evaluated were phytoplankton and benthic invertebrates in very good ecological status, fish classified in good ecological status.

In terms of general physicochemical elements, the water body was in good status.

In terms of specific pollutants, the water body was in good condition.

The water body was in good ecological status.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B3 (BEGA - cf. Chizdia-cf. Behela)

Assessment of the ecological potential of the water body

From the point of view of biological elements, the water body was within moderate ecological potential. The biological elements evaluated were phytoplankton and benthic invertebrates with maximum ecological potential. In the final classification of biological elements, the last monitoring for fish in 2012, assessed with moderate ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body has a good ecological potential.

In terms of specific pollutants, the water body has a good ecological potential.

The water body was within good ecological potential, fish were not taken into account when complying, due to improper conditions of ichthyofauna sampling (period of heavy rains, high turbidity, high water speed, strong wind).

Following the assessment of chemical status, the water body was in good status.

Water body RW5.1_B4 (BEGA - cf. Behela-frontier),

From the point of view of biological elements, the water body has a good ecological potential. The biological elements evaluated were phytoplankton with maximum ecological potential and benthic invertebrates with good ecological potential. In the final classification of biological elements, the last monitoring for fish in 2012, assessed with good ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body fell into moderate ecological potential, due to the indicators related to the nutrient group.

In terms of specific pollutants, the water body has a good ecological potential.

The water body was within good ecological potential, for physicochemical elements were taken into account statistical quantities at 75% percentile.

Following the assessment of chemical status, the water body was in good status.

Assessment of the status of water bodies in 2016

The RW5.1_B1 water body (BEGA - spring-cf. Bega Poienilor + tributaries)

From the point of view of biological elements, the water body was in very good ecological status. The biological elements evaluated were Phyto benthos and benthic invertebrates in very good ecological condition.

From the point of view of general physicochemical elements, the water body fell into the moderate state, due to the indicators related to the nutrient group.

In terms of specific pollutants, the water body was in good condition.

The water body was in good ecological status.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B2 (BEGA - cf. Bega Poienilor-cf. Chizdia)

From the point of view of biological elements, the water body was in very good ecological status. The biological elements evaluated were phytoplankton and benthic invertebrates in very good ecological status.

From the point of view of general physicochemical elements, the water body fell into the moderate state, due to the indicators related to the group of oxygenation conditions.

In terms of specific pollutants, the water body was in very good condition.

The water body was in good ecological status.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B3 (BEGA - cf. Chizdia-cf. Behela)

From the point of view of biological elements, the water body has a good ecological potential. The biological elements evaluated were phytoplankton and benthic invertebrates with maximum ecological potential. In the final classification of biological elements, the last monitoring for fish in 2016, assessed with good ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body fell into moderate ecological potential due to the indicators related to the group oxygenation conditions.

In terms of specific pollutants, the water body has a good ecological potential.

The water body was within good ecological potential.

Following the assessment of chemical status, the water body was in good status.

Water body RW5.1_B4 (BEGA - cf. Behela-frontier)

From the point of view of biological elements, the water body has a good ecological potential. The biological elements evaluated were phytoplankton with maximum ecological potential and benthic invertebrates with good ecological potential. In the final classification of biological elements, the last monitoring for fish in 2016, assessed with good ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body fell into moderate ecological potential, due to the indicators related to the group oxygenation conditions and nutrients.

In terms of specific pollutants, the water body has a good ecological potential.

The water body was within good ecological potential.

Following the assessment of chemical status, the water body was in good status.

Assessment of the status of water bodies in 2017

The RW5.1_B1 water body (BEGA - spring-cf. Bega Poienilor + tributaries)

In terms of biological elements, the water body was in good ecological status. The biological elements evaluated were Phyto benthos and benthic invertebrates in very good ecological condition. In the final classification of biological elements, the last monitoring for fish in 2015, assessed with good ecological status, was taken into account.

From the point of view of general physicochemical elements, the water body fell into the moderate state, due to the indicators related to the nutrient group.

In terms of specific pollutants, the water body was in very good condition.

The water body was in good ecological status.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B2 (BEGA - cf. Bega Poienilor-cf. Chizdia)

In terms of biological elements, the water body was in good ecological status. The biological elements evaluated were phytoplankton and benthic invertebrates in very good ecological status. In the final classification of biological elements, the last monitoring for fish in 2015, assessed with good ecological status, was taken into account.

In terms of general physicochemical elements, the water body was in good status.

In terms of specific pollutants, the water body was moderate.

The water body has been in moderate ecological status is determined by specific pollutants.

Following the assessment of chemical status, the water body was in good status.

The water body RW5.1_B3 (BEGA - cf. Chizdia-cf. Behela)

From the point of view of biological elements, the water body has a good ecological potential. The biological elements evaluated were phytoplankton with maximum ecological potential and benthic invertebrates with good ecological potential. In the final classification of biological elements, the monitoring of ichthyofauna in 2016, assessed with good ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body has a good ecological potential.

In terms of specific pollutants, the water body was within moderate ecological potential.

The classification of the water body in moderate ecological potential is determined by specific pollutants.

Following the assessment of chemical status, the water body was in good status.

Water body RW5.1_B4 (BEGA - cf. Behela-frontier),

From the point of view of biological elements, the water body has a good ecological potential. The biological elements evaluated were phytoplankton with maximum ecological potential and benthic invertebrates with good ecological potential. In the final classification of biological elements, the monitoring of ichthyofauna in 2016, assessed with good ecological potential, was taken into account.

From the point of view of physicochemical elements, the water body fell into moderate ecological potential, due to the indicators related to the group oxygenation conditions.

In terms of specific pollutants, the water body was within moderate ecological potential.

The classification of the water body in moderate ecological potential is determined by the physicochemical elements.

Following the assessment of chemical status, the water body was in good status.

Assessment of the status of water bodies in 2018-2020

Water body RORW5-1_B1 BEGA - spring-cf. Bega Poienilor + tributaries

1.Assessment of the ecological status of the water body with regard to:

a. Biological elements - the water body has been in GOOD ecological status. The biological elements evaluated were Phyto benthos classified in GOOD ecological status, benthic invertebrates and aquatic macrophytes classified in VERY GOOD ecological status.

b. General physicochemical elements, the water body has been in GOOD ecological status due to indicators related to oxygenation, salinity and nutrient conditions.

c. Specific pollutants, the water body was in VERY GOOD ecological status.

d. In an integrated ecological status assessment, the water body was in GOOD ecological status

2.Assessment of the chemical status of the water body

Following the assessment of chemical status (water investigation environment), the water body was in GOOD chemical status.

By excluding ubiquitous PBTs, the chemical status of the water body is GOOD.

Water body RORW5-1_B2 BEGA - cf. Bega Poienilor-cf. Chizdia

1.Assessment of the ecological status of the water body with regard to:

a. Biological elements - the water body has been in VERY GOOD ecological status. The biological elements evaluated were phytoplankton, benthic invertebrates and aquatic macrophytes classified in VERY GOOD ecological status.

B .General physicochemical elements, the water body was in GOOD ecological status, due to the indicators related to the groups oxygenation and salinity conditions.

c. Specific pollutants, the water body was in VERY GOOD ecological status.

d. In an integrated ecological status assessment, the water body was in GOOD ecological status.

2.Assessment of the chemical status of the water body

Following the assessment of the chemical status (water / biota investigation environment), the water body fell into BAD chemical status, the indicators that determined the failure to achieve the quality objective (good chemical status) being lead – water and mercury investigation medium and brominated diphenyl ethers (BDE) – biota investigation environment

By excluding ubiquitous PBTs, the chemical status of the water body is BAD.

Water body RORW5-1_B3 BEGA - cf. Chizdia-cf. Behela

1.Assessment of the ecological potential of the water body in terms of:

a. Biological elements - the water body was within MAXIMUM ecological potential. The biological elements evaluated were phytoplankton and benthic invertebrates classified in MAXIMUM ecological potential.

b. General physicochemical elements, the water body has fallen into GOOD ecological potential, due to the indicators related to the groups oxygenation and salinity conditions.

c. Specific pollutants, the water body has been within the MAXIMUM ecological potential.

d. In an integrated ecological potential assessment, the water body has been classified as GOOD ecological potential.

2.Assessment of the chemical status of the water body

Following the assessment of chemical status (water investigation environment), the water body was in GOOD chemical status.

By excluding ubiquitous PBTs, the chemical status of the water body is GOOD.

Water body RORW5-1_B4 BEGA - cf. Behela-border,

Assessment of the ecological potential of the water body in terms of:

1.Assessment of the ecological potential of the water body in terms of:

a. Biological elements - the water body was within GOOD ecological potential. The biological elements evaluated were phytoplankton classified in MAXIM ecological potential and benthic invertebrates classified in GOOD ecological potential.

b .General physicochemical elements, the water body has been included in GOOD ecological potential, due to the indicators related to the groups oxygenation, salinity and nutrients.

c. Specific pollutants, the water body has been within the MAXIMUM ecological potential.

d.In an integrated ecological potential assessment, the water body has been classified as GOOD ecological potential.

2.Assessment of the chemical status of the water body

Following the assessment of the chemical status (water/biota investigation environment), the water body fell into BAD chemical status, the substances that determined the failure to achieve the quality objective (good chemical status) being dissolved mercury, brominated diphenyl ethers (BDE) and Heptachlor and heptachlor epoxide for the biota investigation environment.

By excluding ubiquitous PBTs, the chemical status of the water body is good.

Volumes of water abstracted from the Bega River

From the Bega River, 2 localities are supplied with water for the population: Timișoara and Tomești. Timisoara is supplied from two sources, about 24% of drinking water comes from deep boreholes, located in the east, southeast and west of the city and 76% from the Bega canal.

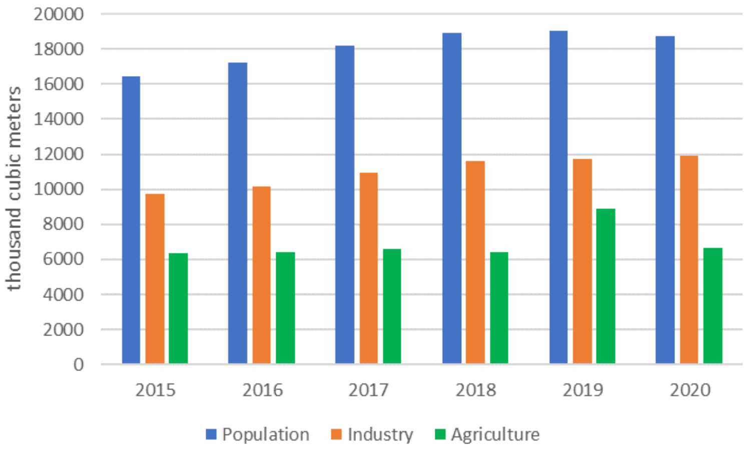

Figure 2. Volume of water abstracted from Bega

Volumes of water discharged into the Bega River

Human agglomerations that discharge into the Bega River have a unitary sewerage system (domestic water mixes with rainwater). As shown in Figure 3, the trend is variable and is strongly influenced by the amounts of precipitation collected on the hearths of the human agglomerations served.

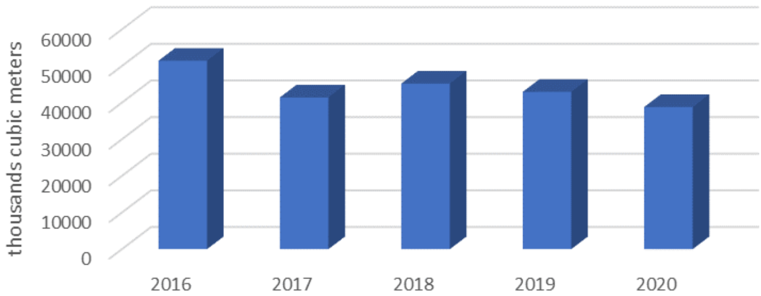

Figure 3. Volume of water discharged into the Bega River from urban agglomerations

In the case of industrial units, the type of discharged water is technological and pluvial. Figure 4 shows that the trend is variable over a period of 5 years, being influenced by the amounts of precipitation collected from the concrete surfaces of the industrial units concerned.

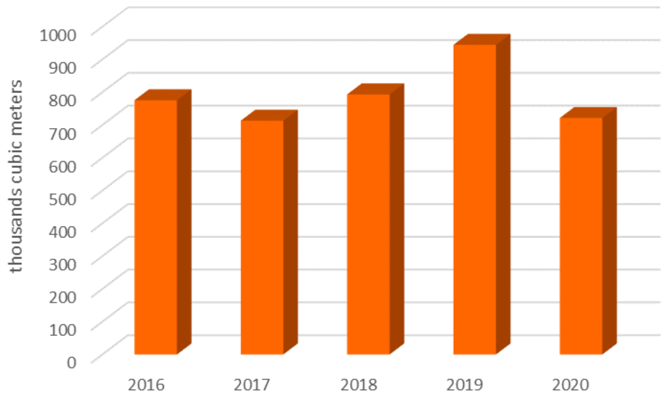

Figure 4. Volume of water discharged into the Bega River from industry

CONCLUSIONS

Analysing the elements of global characterization of the water quality of the Bega River, it results that the water quality is adequate on the river sections located in the upper part of the hydrographic basin, up to the upstream of Timisoara. The achievement of the objective of 'good' water quality on these water bodies is generally determined by the absence of significant sources of pollution. The slight exceedances of the flow-weighted concentration of the indicators come from diffuse natural pollution sources, being more pronounced during periods of heavy rainfall, but they do not influence the overall water quality category of the Bega River.

It can be judged that water bodies on the river achieve the quality objective.

Due to the large number of pressures that water resources are suffering, it is vital to develop effective legislative instruments to help secure these resources for future generations.

The conservation, protection and improvement of the quality of the aquatic environment starts from considering the vulnerability of this environment and takes place under the conditions of sustainable use of water resources, based on the principles of precaution, prevention, avoidance of damage at source, as well as the polluter pays.

The care of water managers refers to all activities which, through technical means and legislative, economic and administrative measures, lead to knowledge, use, rational use of water resources, to their maintenance and improvement in terms of quality and quantity to meet social and economic needs by protecting waters against depletion and pollution.

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