Chapter

Water Quality and Anthropogenic Pressures in a Changing Environment: The Arges River Basin, Romania

Daniel Dunea

Abstract

The objective of this work was to present several benchmarks regarding the water quality at hydrological basin level under increasing anthropogenic pressures. The first part briefly describes the sources of water pollution, the hydromorphological pressures, and the main water quality parameters widely used for the assessment. The second part presents as an example the dynamics of several water quality parameters recorded between 2007 and 2014 downstream of Argeș River, Romania, near the confluence with the Danube River. Argeș River supplies water for several important Romanian cities including Bucharest, and from here comes the rationale of the work, which envisages characterizing water quality status to substantiate proper water management. The following parameters were statistically analyzed: water temperature, suspended solids, pH, dissolved oxygen, biochemical oxygen demand, ammonium, nitrates, nitrites, and dissolved heavy metals. The factor analysis results showed that the first factor contains temperature and dissolved oxygen, the second has the heavy metals, the third groups have the ammonium and pH, the fourth contains the TSS and nitrites, while the fifth is formed by BOD5 and nitrates. Water quality plays a significant role in promoting socioeconomic development and maintaining viable ecosystems. The protection of water quality requires improved monitoring and reliable watershed management plans.

Keywords: EU Water Framework Directive, pollution sources, Argeș River, water monitoring, biological oxygen demand, heavy metals

1. Introduction

1.1 The current state of knowledge about water quality protection in the European Union

The EU Water Framework Directive (WFD), adopted on 23 October 2000 and implemented since 22 December 2000, when it was published in the Official Journal of the European Union (OJ L 327), has as its main objective the achievement of good status for all bodies of water (surface and groundwater), and for artificial bodies, the good ecological potential was defined [1]. This requires an analysis of anthropogenic pressures and their impact, as set out in Article 5 of the WFD, which states: "*Each Member State must review the impact of human activities on the state of surface and groundwater in each district of the river basin or for a portion of a district of an international river basin situated in its territory*." WISE is the Water Information System for Europe, an information gateway for stakeholders regarding the European water issues comprising data collected by dedicated EU institutions [2].

Watershed management plans are management tools in Integrated Water Resources Management, which generally contain descriptions of water resources in a drainage basin and the associated management schemes and applications considering the economic efficiency and the social component in the use of water as important pillars [3]. River basin management plans come as a requirement of the WFD and are means of achieving the protection, improvement, and sustainable use of water resources. This includes fresh surface water (lakes, rivers, and streams), groundwater, and ecosystems such as some wetlands that depend on groundwater, estuaries, and coastal waters [4]. At the river basin level, it is important to identify the pressures and estimate the anthropogenic impact on the state of surface and groundwater, this aspect being achieved by identifying the activities carried out at the river basin level and significant pressures, followed by the impact assessment and measures [5]. Consequently, the actions envisage the improvement of the water body conditions [6].

The identification of significant pressures as well as the impact of human activities on the state of surface waters and groundwater [7] takes into account the following aspects:

- point sources of significant pollution;
- sources of diffuse pollution, including land use impact;
- hydromorphological pressures.

Water resources management is the activity of planning, development, distribution, and optimal management of water resources, water resources management planning takes into account all competing water demands and tries to allocate water to meet all uses and requirements. Within the management of water resources, the following major categories of problems have been identified: pollution with organic substances, pollution with nutrients, pollution with priority hazardous substances, and hydromorphological pressures [8].

Pollution with organic substances is due to wastewater discharges from point and diffuse sources represented by human settlements, industrial and agricultural sources having a significant impact on aquatic ecosystems [9]. Nutrient pollution of water refers to contamination with excessive nutrient inputs, this being the main cause of eutrophication of surface waters, in which excess nutrients, usually nitrogen or phosphorus, stimulate the growth of algae. Sources of nutrient pollution include spills from agricultural fields and pastures, discharges from septic tanks, and emissions from combustion [10]. Pollution with hazardous substances emitted into water bodies occurs both directly and indirectly through a series of diffuse or point sources, these substances are toxic and have persistence and bioaccumulation in the aquatic environment [11].

The objective of this work was to establish the key benchmarks regarding water quality resilience under increasing anthropogenic pressures in a changing environment determined by climate change. In the first part, the sources of water pollution (point and diffuse), the hydromorphological pressures, and the main water quality parameters have been briefly described. In the second part, the dynamics of several water quality parameters recorded downstream of Argeș River, Romania, near the confluence with the Danube

River, from 2007 to 2014 were presented as an example for water quality dynamics in conjunction with the anthropogenic impact and enforced environmental regulations.

1.2 Significant point sources of water pollution

According to the WFD, there are certain limits above which pressures become significant, so the size of the pressure is compared to a relevant limit value for a body of water [1]. Regarding the discharge of treated or untreated water into surface waters, the following significant pressures are identified:

- human agglomerations with more than 2000 equivalent inhabitants and wastewater collection systems, with or without wastewater treatment plants, but also agglomerations of less than 2000 equivalent inhabitants with centralized or unitary sewerage systems are considered point sources of significant pollution [1].

- an industry with installations covered by the Directive on integrated pollution prevention and control; with units that discharge hazardous substances beyond the limits of the legislation in force, or other units that do not comply with the legislation in force and evacuate in surface water resources [1].

- agriculture with livestock farms covered by the Directive on integrated pollution prevention and control—96/61/EC (IPPC Directive); with farms that discharge hazardous substances beyond the limits of the legislation and do not comply with it [12].

Human agglomerations contribute with significant amounts of organic matter (CCO and BOD_5), nutrients (total nitrogen and total phosphorus), and heavy metals (Cu, Zn, Cd, Ni, Pb, Cr, Hg) when it comes to the discharge of pollutants into surface water resources, as there are still numerous human settlements that do not comply with the requirements of the Urban Wastewater Treatment Directive (Directive 91/271/EEC) [13]. There are specific sources of industrial and agricultural pollution that must meet certain requirements, such as integrated pollution prevention and control, pollution from hazardous substances, protection of waters against nitrate pollution from agricultural sources, and pollution occurring from major accidents [14].

1.3 Significant diffuse sources of pollution including land use

Water pollution, such as sewage or industrial effluent pollution, is normally easier to monitor because it generally occurs from a single source, but diffuse water pollution results from multiple sources [15]. Diffuse water pollution is a widespread problem and it is important to know the extent to which different sources of diffuse pollution have an impact on water quality [16], agriculture being one of the main sources of diffuse pollution. Various activities contribute to diffuse pollution indicating agriculture, forestry, mining, construction, and urban life, and the local climate, geology, and other natural phenomena that can influence the size and extent of the problem. In agriculture, diffuse pollutants include sludge from soil erosion, nutrients from fertilizer application, or non-compliance with pesticide handling and chemical application legislation—Directive 2009/128/EC [17].

As in the case of point sources of significant pollution, the main categories are represented by:

- human agglomerations without wastewater collection systems and compliant landfills;

- agriculture, there are zootechnical farms that do not have systems for storage or use of compliant manure and as a result, there are vulnerable areas in terms of pollution with nitrates from agricultural sources, and by non-compliance with current legislation frequently appear areas polluted with pesticides;

- regarding the industry, the diffuse sources of pollution are represented by the storage of waste in non—compliant landfills, raw material landfills, accidental pollution within the units, the existence of abandoned industrial sites.

Eutrophication is the enrichment of water with nutrients such as nitrate or phosphate, causing an accelerated development of algae and higher plants, which leads to unwanted disturbance of the balance of organisms in the water but also to water quality in general [18]. Thus, habitat disturbances occur for fish and invertebrate species, the development of toxic algae with an impact on the fishing industry, and the flourishing of recreational waters lead to the closure of the navigation or recreational use area with an impact on the tourism and leisure industry [19]. Loss of nutrients or agrochemicals in soil and water in addition to affecting the environment is also an agricultural financial loss. In addition, groundwater is endangered due to leakage or percolation of nutrients and pesticides from the land surface. Diffuse agricultural pollution is mainly associated with soil particles, pesticides, and other potentially toxic chemicals, including veterinary medicines, nutrients, pathogens, bacteria from animal waste, and manure spread on the ground [20].

1.4 Significant hydromorphological pressures

The main hydromorphological pressures identified in the risk analyzes are hydropower, flood protection, navigation, and agriculture. There are other activities of some importance, such as urbanization, water use for irrigation, outdoor recreational activities, and fishing. Hydromorphological pressures are often generated by the performance of hydrotechnical works, such as dams for hydropower generation, flood protection, as well as water capture or construction of navigation canals [21].

Hydromorphological pressures affect watercourses in river basins, the most important hydromorphological pressures being caused by:

- regularization and dam works that bring changes related to the morphology of watercourses;

- execution of derivations with the role of supplementing the tributary flow for certain accumulations and ensuring the water requirement for the afferent localities;

- storage lakes that are built for drinking and industrial water supply, having a role of protection against floods, or with those used for irrigation, fish farming, or for energy purposes;

- navigable canals, that modify the morphology of the riverbed, the navigation representing a significant pressure on the waters due to the risk of accidental pollution.

These hydromorphological changes such as dams, reservoirs, canals, diversions with changes in the profile of the surface water body, can in turn cause changes such as interruptions of sediment transport, changes in hydraulic and hydrological characteristics (reduced water flow), loss of areas flooding or drying of wetlands, as well as the direct damage to the biota and disruption of biological continuity. The impact of these changes and the subsequent effects lead to the disappearance of aquatic communities [22].

1.5 Surface water quality categories

In general, the quality of surface water is determined by its loading with mineral or organic substances, suspended particles, living organisms, and dissolved gases, and in terms of water quality characteristics, the following terms are generally used [23]:

- water quality indicators;
- water quality parameters;
- water quality criteria;
- standardized water quality values.

Water quality indicators provide basic information and help identify the trends of the changes in water quality over time. The most important indicators considered in the monitoring strategies and plants are dissolved oxygen, biological oxygen demand, water temperature, pH, nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3), metals, transparency, turbidity, coliforms, etc. [24, 25].

Dissolved oxygen (DO) is essential for plants and animals, but at high levels, in water, it can be harmful to fish and other aquatic organisms. Dissolved oxygen is measured in milligrams per liter (mg/L). Expected levels range between 4.0 and 12.0 mg/L [24].

Biological oxygen demand (BOD) is the amount of oxygen consumed by bacteria in the breakdown of organic matter. It also includes the oxygen needed to oxidize various chemicals in water, such as ammonia. BOD is determined by measuring the level of dissolved oxygen in a freshly collected sample and comparing it with the level of dissolved oxygen in a sample that was collected at the same time but incubated under specific conditions for several days. The difference in oxygen reading between the two samples is recorded in units of mg/L. Unpolluted, natural water should have a BOD level of 5 mg/L or even less, and wastewater may have BOD levels varying from 150 to 300 mg/L [25].

Water temperature affects many other parameters of water, including the amount of available dissolved oxygen, the types of plants and animals present, and the susceptibility of organisms to parasites, pollution, and diseases. The temperature is measured in degrees Celsius (°C). Seasonal trends: May–October: 22–35°C, from November to April: 2–27°C [24].

The *pH* test measures the alkalinity or acidity of the water. A pH of 7 is neutral, below 7 is acidic, and above 7 it is basic or alkaline. Acid rain, car leaks, or coal-fired power plants cause a drop in water pH [24]. Pollution from accidental spills, agricultural spills, and sewage spills can also change the pH. While juvenile fish and insect larvae are sensitive to low pH (acid), extreme values at each end of the scale can be lethal to most organisms. Expected levels are 6.5–9.0 [25].

Nitrogen from the atmosphere or soil can undergo many complex chemical and biological changes, being a necessary nutrient for the growth of all living organisms. Nitrogen is found in natural waters in various forms: *nitrate* (NO_3), *nitrite* (NO_2), and *ammonia* (NH_3). The test results are usually expressed as nitrate-nitrogen. Ammonia is the least stable form of nitrogen and thus it is difficult to measure it accurately. In large quantities, nitrates lead to excess growth of algae. Under certain conditions, high levels of nitrates (10 mg/L or more) in drinking water can be toxic to humans and have also been linked to serious illness and even death in infants. Nitrates are expressed in milligrams per liter (mg/L) [25]. *Ammonia* is one of the most important pollutants in the aquatic environment due to its extremely toxic nature. It is discharged in large quantities into industrial, municipal, and agricultural wastewater [24]. *Nitrite* (NO_2) is extremely toxic to the aquatic environment but is usually present in very small amounts in most natural water systems because it is rapidly oxidized to nitrate. Organic nitrogen and ammonia can be determined together and have been referred to as "Kjeldahl nitrogen, or TKN", a term that reflects the technique used in their determination (edition 19, Standard Methods, 1995).

Transparency is the quality of water to let the light energy through. Sunlight provides photosynthetic energy and determines the depth at which algae and other plants can grow. A change in the clarity of the water can be observed after heavy rains when mud and other debris cause decreased visibility [24].

The *turbidity* of water represents its lack of transparency being caused by suspended solid particles and plankton (microscopic plants and animals), which cannot be individualized with the naked eye. A low level of turbidity indicates a healthy ecosystem with moderate amounts of plankton, but a higher level of turbidity raises many problems for flow systems, surface water temperature can rise above normal, as particles suspended close to the water surface facilitate absorption heat from the sun. Suspended particles can carry nutrients, pesticides, and other pollutants and cloudy waters may have low levels of dissolved oxygen [25].

Water quality standards are based exclusively on scientific data on the relationship between pollutant concentrations and their effects on the environment and human health. The quality criteria provide a framework for the control of discharges and pollutant emissions [23]. Water quality standards define the water quality objectives in a body of water by designating beneficial uses and establishing criteria to protect those uses [14]. Beneficial uses may include fishing, swimming, aquatic habitat, navigation, agriculture, etc.

2. Case study: the Argeș River, Romania

2.1 Study area

The water quality parameters were recorded within the Transnational Monitoring Network of the Danube River (TNMN) in Argeș River located in Southern Romania. Argeș River is a left tributary of the Danube being 350 km long and having a basin area of approximately 12,550 km^2, which is 5.3% of Romania's total area (**Figure 1**). The source is located in the Făgăraș Mountains, and it flows into the Danube River at Oltenița.

2.2 Methodology

Corine Land Cover [26] database was used to perform the land use/land cover analysis using the ArcGIS Desktop functions (https://www.ecologic.eu/sites/default/files/project/2021/Land%20Use%20Analysis%20final%20en.pdf).

The water quality was monitored on Argeș River near the confluence with the Danube River at Clătești village (**Figure 2**) within the TNMN, International Commission for the Protection of the Danube River (ICPDR)—https://www.icpdr.org/wq-db/. From the multitude of the parameters collected in the dataset between

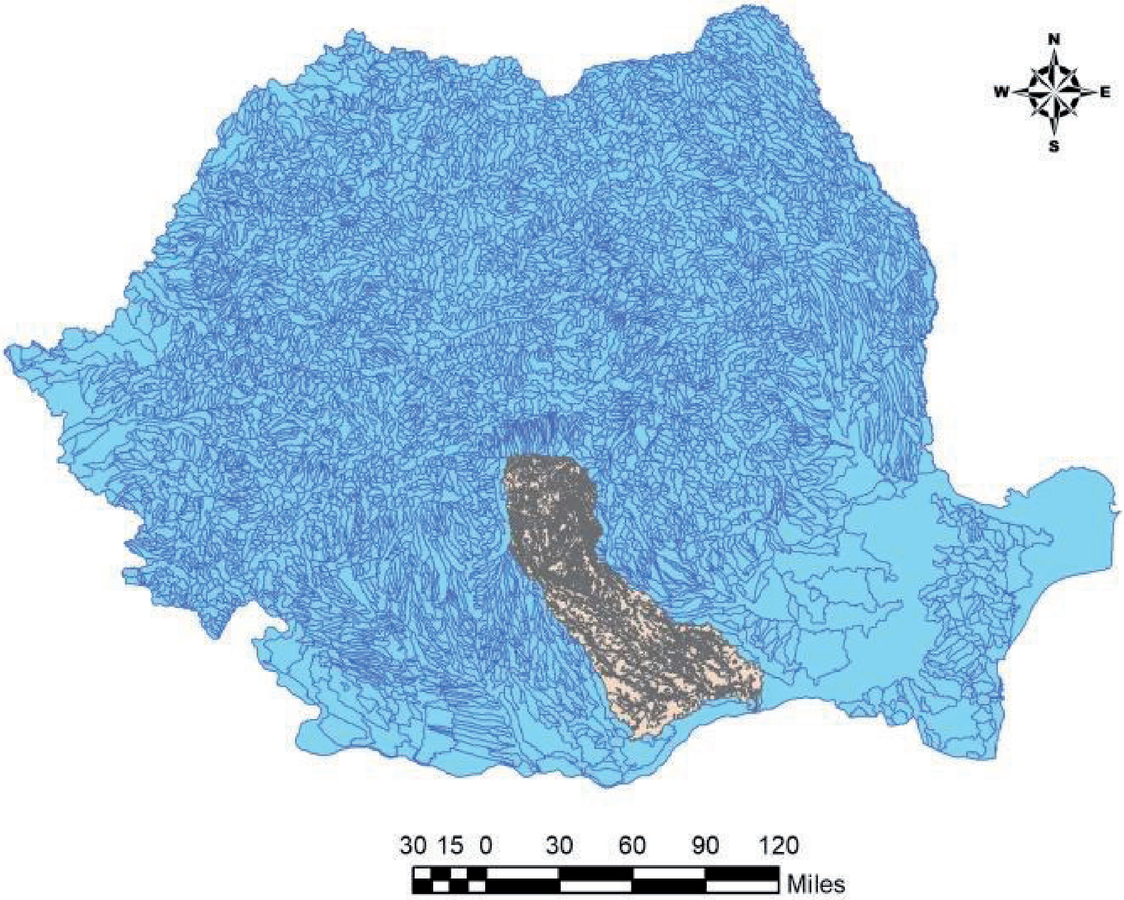

Figure 1.
Argeș River hydrological basin (Code X.1) position in Romania (blue lines represent the delimitations of the subbasins).

2007 and 2014, the following were considered for presentation in this work (n = 95 for each parameter): water temperature (°C), suspended solids—TSS (mg/L), pH, dissolved oxygen—DO (mg/L), biochemical oxygen demand—BOD_5 (mg/L), nitrogen nutrients i.e., ammonium (NH_4-N) (mg/L), nitrates (mg/L), and nitrites (mg/L) and heavy metals (μg/L) i.e., dissolved nickel, chromium, and lead. For these parameters, the sampling, storage, and handling of samples were performed with a monthly frequency being carried out according to the current standards [14]. The start of the time series was considered in the year 2007 because Romania became a member of the EU in that year, and consequently the water quality standards needed to be in agreement with EU legislation.

Statistical analysis was performed using descriptive and associative statistics using the SPSS software (SPSS Inc., Chicago, IL, 2011). Factor analysis considered principal component analysis (PCA) based on Varimax with Kaiser normalization to reduce the number of factors that explain the variability in the dataset.

2.3 Results

In order to have an image of the potential impact of land use within the surfaces existing in the basin of Arges river that drains the waters, the land use analysis was applied (**Figure 3**). The main cities supplied with water in the Arges river basin include the capital Bucharest, and other important cities e.g., Pitești, Curtea de Argeș, Câmpulung, Găești.

Oltenița. The category 112—discontinuous urban fabric occupies 4%. The 211—non-irrigated arable land category reaches 46% showing that the area is important for agriculture. Furthermore, the basin contains a key forest resource

Figure 2.
Position of the monitoring point at Clătești village on Argeș River (arrow) (44.14500N, 26.59900E) https://geoportal.ancpi.ro/portal/apps/webappviewer/index.html?id=5fca89129f2f466882bb7c64e6fd3d98#.

(approximately 3283 km^2) which represents 26.2% of the river basin area and 5.2% of the national forest fund. Watercourses (511 class) represent 12% because the Argeș River gathers 178 codified watercourses with a length of 4579 km (5.8% of the total length of codified watercourses in Romania). The density of watercourses is 0.36 km/km^2.

Figure 4 shows the overall results of the land use analysis.

Land use may have a direct influence on the water quality in the watercourses because of direct discharge and runoff.

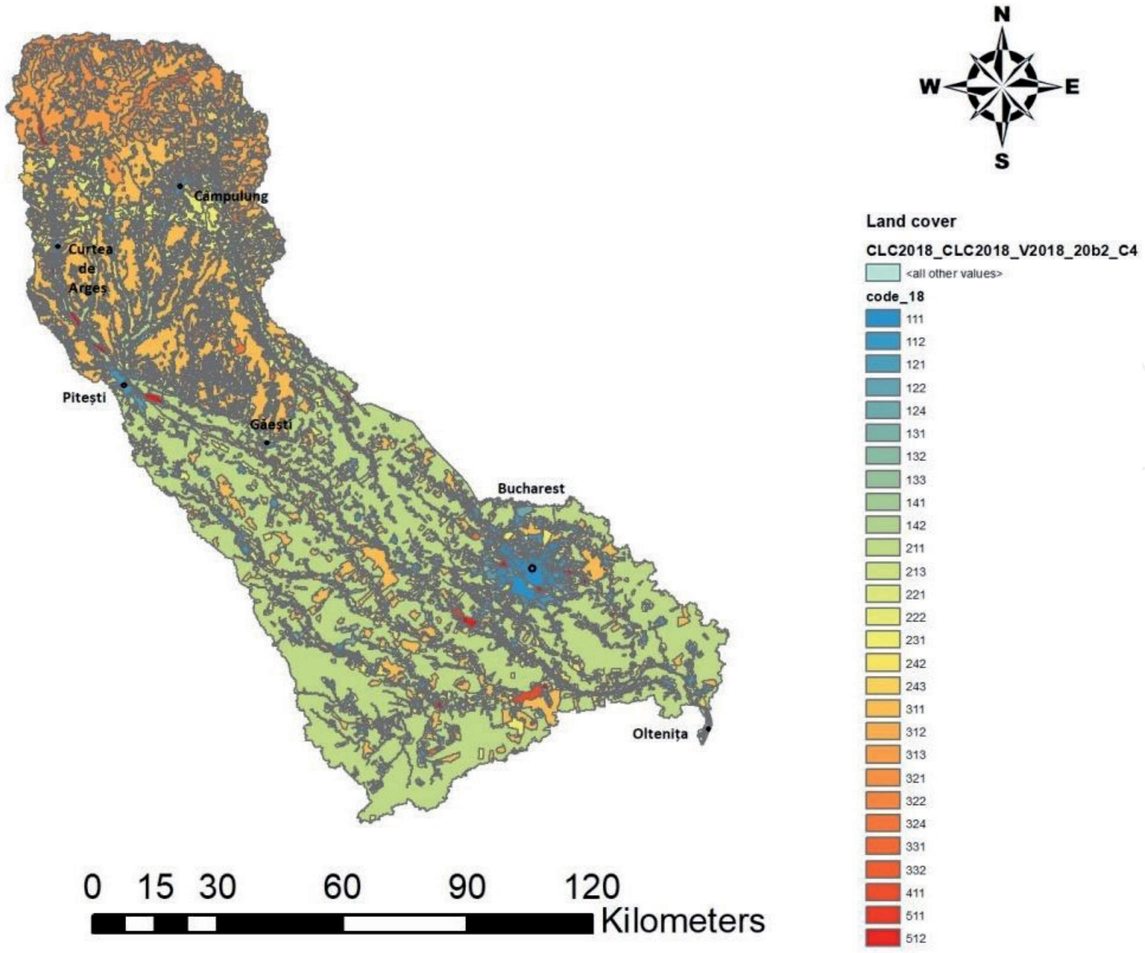

Figure 3.
Land use in the Argeș hydrological basin according to Corine Land Cover.

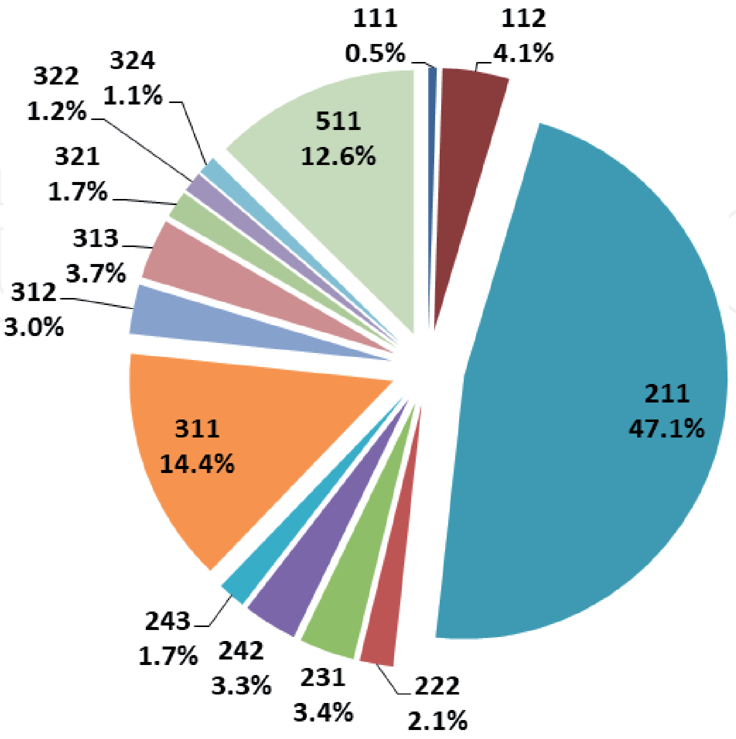

Figure 4.
Analysis of the land use in the Argeș hydrological basin (predominant classes: 112—discontinuous urban fabric 4%; 211—non-irrigated arable land 47%; 311—broad-leaved forest; 14%; 511—watercourses 12%)—details: https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html.

The time series recorded between 2007 and 2014 were plotted for the envisaged parameters to show the dynamics. **Figure 5** presents the fluctuations of pH values for the water samples collected each month. The associated trend line shows a pH value around 7.5, ranging from 6.53 to 8.26 (**Table 1**).

Figure 6 shows the fluctuation of water quality parameters related to oxygen, nutrients, and heavy metals during the monitored period. BOD_5 showed an increasing trend, while DO remained almost constant. Nitrogen parameters decreased from 2007 to 2014. The main statistics for each parameter are presented in **Table 1**.

Dissolved Ni and Pb showed the highest variations in the dataset and these indicators show the magnitude of the anthropogenic impact on the water quality due to the discharge of industrial wastewaters and atmospheric deposition. **Table 2** presents the correlation matrix resulting from applying the Pearson method. The strongest inverse correlations ($p < 0.01$) were found between BOD_5 and dissolved lead, TSS and nitrites, temperature and nitrates, pH and temperature, temperature, and dissolved oxygen. Positive correlations ($p < 0.01$) were established between the dissolved heavy metals suggesting that their concentrations rise together.

The application of factor analysis to the dataset (a matrix of 95 objects by 11 variables) was made using the Varimax with Kaiser normalization [27] to reduce the number of factors that explains the variability. Five components were extracted and from the rotated matrix the factors were organized based on the relevant factor loadings (>0.6). The results showed that the first factor contains temperature and dissolved oxygen, the second has the heavy metals, the third groups the ammonium and pH, the fourth contains the TSS and nitrites, while the fifth is formed by BOD_5 and nitrates. These factors accounted for a cumulative variance of 72.3% of the total variability in the dataset.

Figure 7 summarizes the results of the factor analysis applied to the water quality dataset recorded at Clătești near the confluence of Argeș River with the Danube River.

When compared to the Romanian NTPA-013/2002 limit values (surface waters used for drinking source), the reported concentrations presented exceeding for dissolved Ni, Cr, and Pb. The presence of heavy metals at Clătești monitoring point on Argeș River is a clear indicator of the pressure on the water quality. Furthermore, ammonium exceeded the limit values for class A3 (lowest) and BOD_5 for class A2, respectively. These suggest an increased pollutant load near the discharge of Argeș in the Danube River.

Within the hydrographic basin of the Argeș river, it is necessary to identify and quantify the significant pressures either from punctual sources, with discharges of treated waters or untreated in surface waters (sources of urban pollution/human

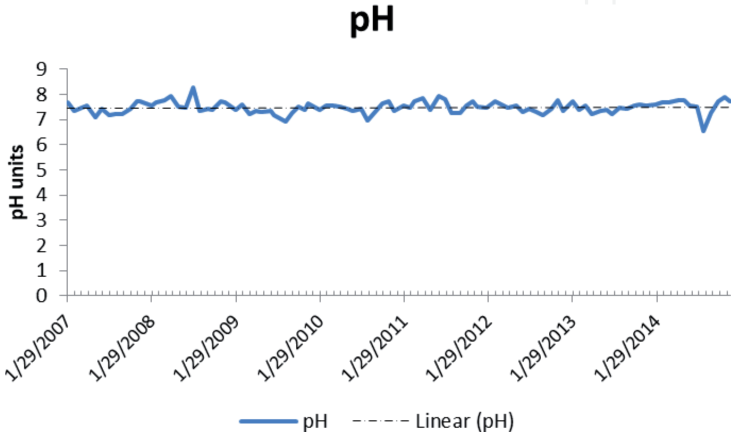

Figure 5.
pH time-series recorded between 2007 and 2014 (monthly concentrations).

Parameter	BOD_5	Suspended solids	Ammonium	Nitrates	pH	Water temperature	DO	Nitrites	Dissolved Ni	Dissolved Cr	Dissolved Pb
Units	mg/L	mg/L	mg/L	mg/L	—	°C	mg/L	mg/L	μg/L	μg/L	μg/L
Count	95	95	95	95	95	95	95	95	95	95	95
Average	4.45	64.09	2.93	1.27	7.48	14.92	7.60	0.07	3.95	1.31	0.69
Median	4.20	54.00	2.65	1.08	7.48	15.00	7.16	0.07	2.40	1.00	0.45
Minimum	2.51	20.00	0.33	0.01	6.53	1.50	4.96	0.01	1.00	0.50	0.16
Maximum	7.20	214.00	7.79	10.70	8.26	29.50	12.59	0.20	49.85	6.80	5.09
Standard deviation	1.07	37.07	1.69	1.19	0.24	8.48	1.85	0.04	6.17	0.78	0.74
Coefficient of variation (%)	24.0	57.8	57.7	94.0	3.2	56.8	24.3	50.6	156.4	59.5	106.8
Skewness	0.58	2.19	0.76	5.42	−0.36	−0.04	0.66	0.90	5.34	4.04	4.24
Kurtosis	−0.34	5.44	0.36	41.91	2.48	−1.34	−0.39	1.21	34.2	25.52	21.27

Table 1.
Descriptive statistics of the parameters recorded at Clătești monitoring point on Argeș River between 2007 and 2014.

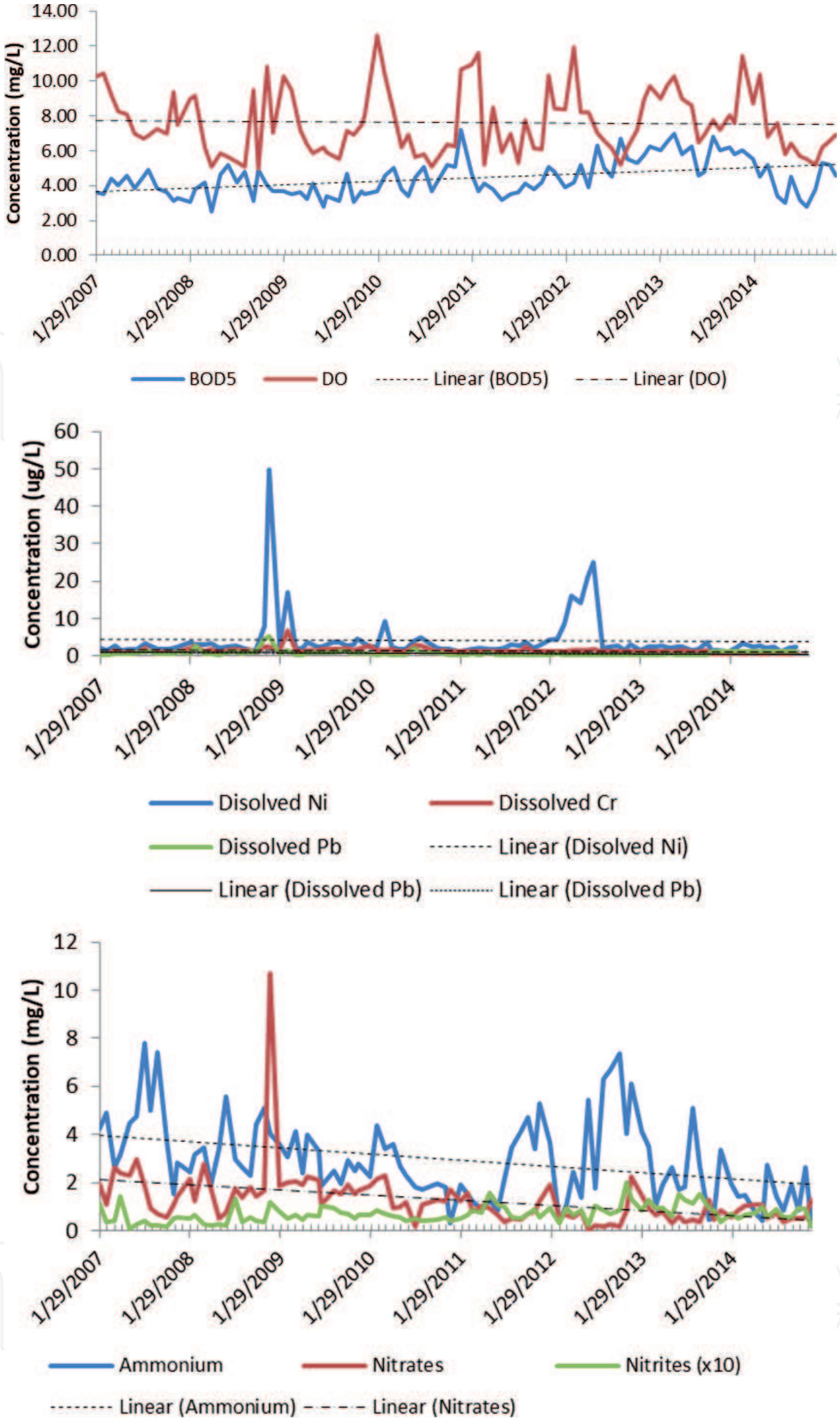

Figure 6.
Dynamics of oxygen-related parameters, dissolved heavy metals, and nitrogen nutrients in the monitoring point on Argeș River.

settlements and/or industrial sources with wastewaters discharged into streams due to non-compliance with the maximum permitted concentrations [28]), or diffuse pollution, from agriculture and other sources.

An investigative monitoring program is needed to identify the causes of exceeding the limits provided in quality standards and other regulations in the field of water management, to establish the causes for which a body of water in the Argeș basin cannot achieve the established environmental objectives, but also to quantify the impact on water quality, providing information on the programs of measures

	BOD_5	**TSS**	**Ammonium**	**Nitrates**	**pH**	**Temp**	**DO**	**Nitrites**	**Diss. Ni**	**Diss. Cr**	**Diss. Pb**
BOD_5	1.00	−0.04	0.12	**−0.24**	0.01	−0.07	0.18	**0.20**	0.01	−0.15	**−0.27**
	—	*0.68*	*0.24*	*0.02*	*0.92*	*0.51*	*0.08*	*0.05*	*0.89*	*0.16*	*0.01*
TSS	—	1.00	−0.13	0.07	0.06	−0.12	**0.21**	**−0.27**	−0.10	−0.13	−0.04
	—	—	*0.20*	*0.50*	*0.54*	*0.23*	*0.04*	*0.01*	*0.35*	*0.22*	*0.69*
Ammonium	—	—	1.00	0.12	**−0.24**	0.08	−0.03	−0.13	0.18	0.14	−0.07
	—	—	—	*0.25*	*0.02*	*0.43*	*0.81*	*0.21*	*0.08*	*0.19*	*0.52*
Nitrates	—	—	—	1.00	0.10	**−0.26**	0.10	0.03	−0.06	0.12	0.12
	—	—	—	—	*0.33*	*0.01*	*0.32*	*0.80*	*0.55*	*0.26*	*0.25*
pH	—	—	—	—	1.00	**−0.36**	0.15	0.18	−0.08	−0.07	0.09
	—	—	—	—	—	*0.00*	*0.14*	*0.08*	*0.43*	*0.51*	*0.41*
Temp	—	—	—	—	—	1.00	**−0.76**	0.05	0.02	−0.06	**−0.22**
	—	—	—	—	—	—	*0.00*	*0.61*	*0.88*	*0.54*	*0.04*
DO	—	—	—	—	—	—	1.00	0.01	−0.02	−0.05	0.05
	—	—	—	—	—	—	—	*0.94*	*0.82*	*0.66*	*0.65*
Nitrites	—	—	—	—	—	—	—	1.00	−0.08	**−0.22**	**−0.20**
	—	—	—	—	—	—	—	—	*0.42*	*0.03*	*0.05*
Diss. Ni	—	—	—	—	—	—	—	—	1.00	**0.38**	**0.50**
	—	—	—	—	—	—	—	—	—	*0.00*	*0.00*
Diss. Cr	—	—	—	—	—	—	—	—	—	1.00	**0.34**
	—	—	—	—	—	—	—	—	—	—	*0.00*
Diss. Pb	—	—	—	—	—	—	—	—	—	—	1.00
	—	—	—	—	—	—	—	—	—	—	—

Calculated p is italicized; significant correlations are bolded.

Table 2.
Correlation matrix of the parameters monitored on Argeș River at Clătești between 2007 and 2014.

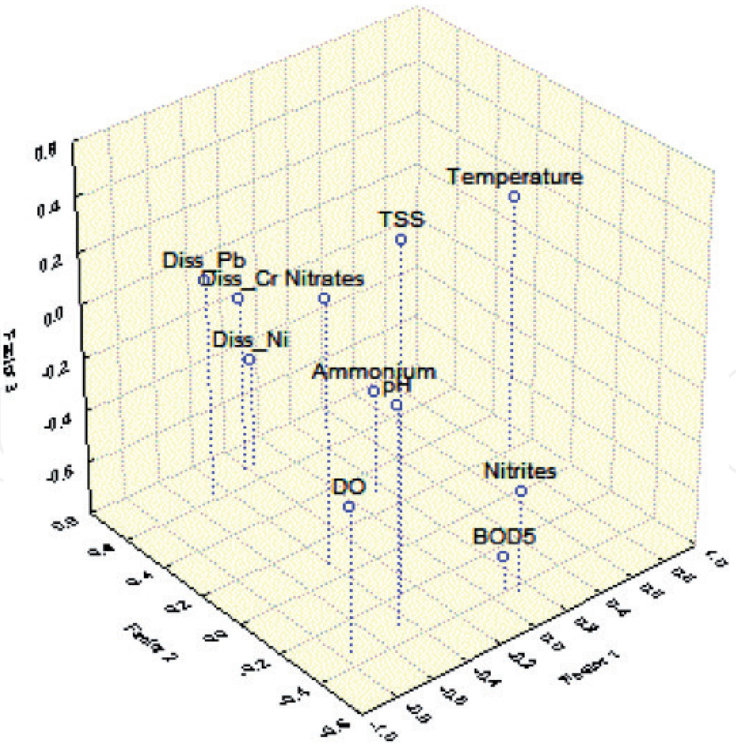

Figure 7.
The component plot in rotated space for the water quality parameters (1st factor, temperature, and dissolved oxygen, 2nd factor, the heavy metals, the 3rd factor, ammonium and pH, 4th factor, TSS and nitrites; 5th factor: BOD_5 and nitrates).

needed to achieve the environmental objectives and the specific measures needed to remediate the effects of accidental pollution [28].

Such tools and measures lead to the completion of knowledge on water quality, to the achievement of an optimal qualitative assessment, to the testing of hypotheses on the assessment of pressures and impact [29].

The aim is also to conserve water-dependent habitats and species, to enable the sustainable use of resources and the efficient management of water resources. These measures are necessary to reduce the hydromorphological pressures, the effects of climate change, the phenomenon of eutrophication in water bodies as well as the protection of groundwaters. At the same time, a better understanding of the situation regarding the spatial distribution of habitats and species is needed in line with the trends in land-use change.

3. Conclusions

Water quality has emerged as one of the main concerns around the world recently, as it plays a significant role in promoting socio-economic development as well as maintaining viable ecosystems. The impact of water quality degradation has serious consequences, including eutrophication, sedimentation, harmful algae proliferation, and hypoxia, which has a negative impact on human settlements and ecosystems in terms of health and economy.

The Argeș River from Romania encounters significant pressures from anthropogenic factors as well as other rivers [30] that pass highly inhabited areas with moderate efficiency of wastewater treatment. In addition to the potentially significant pressures already presented above, other types of activities/pressures may affect the condition of water bodies such as accidental pollution, fishing, and aquaculture activities, ballast and sand extraction from minor riverbeds, forest exploitation, unidentified pressures, etc. [31].

The following recommendations are suggested to maintain or improve future water quality at the hydrological basin level:

a. stopping the discharge of untreated wastewater directly into water bodies and the implementation of modern wastewater treatment facilities for the proper treatment of wastewaters before discharging. Therefore, strict environmental regulations are required to manage these negative aspects;

b. the use of state-of-the-art technologies of water management, and monitoring to identify the causes and sources of pollution, as well as improvement of policy strategies;

c. capacity building and environmental ethics through communication, environmental education, training, and awareness that will improve waste management and water use;

d. cooperating with local stakeholders of water use, such as farmers, local institutions and non-governmental organizations, to facilitate the acceptance of new technologies and environmental policies in the context of climate change.

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Conflict of interest

The author declares no conflict of interest.

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Author details

Daniel Dunea
Valahia University of Târgoviște, Târgoviște, Romania

*Address all correspondence to: dan.dunea@valahia.ro

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