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Water Quality Status in the Erzeni River, Albania over the Period 2014–2019 and Prospective Towards the Achievements of EU WFD Objectives in Its Basin

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Abstract: *Erzeni River flows through two of the most developed regions of Albania: Tirana and Durrës. Due to the concerns about potential pollution resulting from increased human activities in its basin the major driving forces and pressures were identified and the quality of the river's water was assessed based on an evaluation of physicochemical parameters based on monitoring data over the period 2014 – 2019. Based on data analysis, the evaluation of the overall water quality status has been carried out. The assessment of the physicochemical parameters measured, and the use of the Water Quality Standards methodology show a deterioration of water quality, however, this remains moderately good. A more precise quantification of pressures and consequent evaluation of impacts, though feasible, requires significant amounts of good quality data, much of which is not currently collected in Albania. Significant improvements in data collection and coordination between competent authorities will be required as part of future measures.*

1. INTRODUCTION

The Erzeni has a length of 109 km, and the drainage basin covers a total area of 760 km2. The river is at present the only river that provides sediment to the beaches in the Gulf of Lalezi. It has the lowest mean yearly water discharge (18 m³/sec) of all Albanian rivers and an average sediment load of 4 x 106 tons/year. The river has its origin in the Mali me Gropa 1,200 m a.s.l. some 25 km east of Tirana near Shëngjergi. It flows northwest through Petrelë and Sukth to the Adriatic Sea 12 km north of Durrës. The river passes through the city of Tirana, only a few kilometers from its southern end. Only a small range of hills separates the valley of the Erzeni River from the Lana, Tirana, Zeza, and Tërkuza rivers that form the Ishem River. On the southwestern outskirts of Yzberisht, the transition from the plane to the Erzeni valley is barely perceptible. The mouth is between Durres and the headland of Cape of Rodon at Lalzi bay.

In 2019 the population living in the basin was estimated by INSTAT in 289.011 people, mainly divided among the Municipalities of Durrës, Tiranë, Vorë, Durres, Kavajë, Shijak, Rrogozhinë.

The monitoring network of surface water quality (rivers, lakes, transitional and coastal waters) in the Erzeni River basins, and the associated sampling programmes, are under the competent authority of the National Environmental Agency (NEA) of the Ministry of Tourism and Environment.[3] The NEA publishes annually the National Environmental Monitoring Program, which sets out the intended monitoring sites and the target parameters.

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3 Government of Albania - DCM No 1189 - "On the rules and procedures for implementation of the National Monitoring Program", 2009

The laboratory of the National Environmental Agency works in accordance with the Quality Manual ISO 17025:2017 and is accredited for the main physic-chemical parameters: pH, conductivity, alkalinity, suspended solids, chemical oxygen demand, biochemical oxygen demand, nitrite, nitrate, ammonium, ortho–phosphorous and total phosphorous.

Currently, due to resource and capacity limitations, biological quality elements (BQEs) are not routinely sampled or analysed in Albania.

The water monitoring network extends across the main river only (Erzeni) and does not represent most of the waterbodies delineated in the river basins. Thus, the current NEA programme does not fulfil the compliance requirements of WFD Annex V 1.3.

Selected results from the monitoring network are shown for the parameters of BOD_5, P, and NH_4 (Table 1, Table 2, and Table 3). These three parameters are good general indicators of pollution arising from anthropogenic sources that are likely harmful to aquatic systems.

Table 4 provides the scheme for classification of the physic-chemical quality of rivers applied in Albania, which although distinguishing five classes, labelled from "high" to "bad" – is not yet designed fully in accordance with the requirements of the WFD.

Table 4. A classification scheme for assessment of physic-chemical parameters in rivers

Parameters	Unit	Parameter limit values				
		High Status (I)	Good Status (II)	Moderate Status (III)	Poor Status (IV)	Bad Status (V)
Dissolved O_2	mg/l	>7	>6	>5	>4	<3
BOD_5	mg/l	< 2	< 3,5	< 7	< 18	> 18
pH (acid)			> 6,5	> 6		
pH (alkaline)			< 8,5	< 9		
NH_4	mg/l	<0,05	<0,3	<0,6	<1,5	>1,5
NO_2	mg/l	<0,01	<0,06	<0,12	<0,3	>0,3
NO_3	mg/l	<0,8	<2	<4	<10	>10
PO_4	mg/l	<0,05	<0,10	<0,2	0,5	>0,5
Total-P	mg/l	<0,1	<0,20	<0,4	<1	>1

Source: National Environment Agency

Available monitoring data and assessment criteria do not yet allow a comprehensive assessment of the environmental state of water bodies. However, some conclusions can already be made.

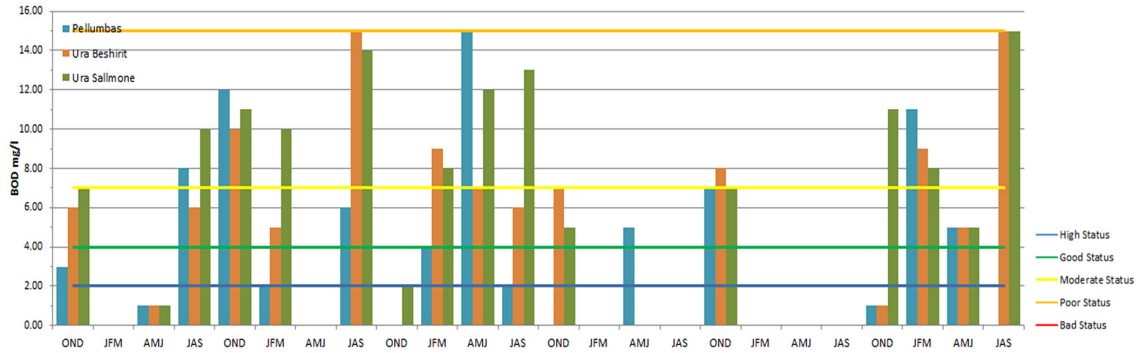

Figure 1. Surface Water Monitoring Data All Stations – Parameter Biochemical Oxygen Demand (BOD_5)

Source: Own research

Table 1. Surface Water Monitoring Data All Stations – Parameter Biochemical Oxygen Demand (BOD5 mg/L)

STATION	2014				2015				2016				2017				2018				2019			
	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Pellumbas	3.0		1.0	8.00	12.0	2.0		6.0	< 1	4.0	15.0	2.0	< 1		5.0		7.0	< 1		< 1	1.0	11.0	5.0	
Ura Beshirit	6.0		1.0	6.0	10.0	5.0		15.0	< 1	9.0	7.0	6.0	7.0		< 1		8.0	< 1		< 1	1.0	9.0	5.0	15.0
Ura Sallmone	7.0		1.0	10.0	11.0	10.0		14.0	2.0	8.0	12.0	13.0	5.0		< 1		7.0	< 1		< 1	11.0	8.0	5.0	15.0

Source: National Environment Agency

Table 2. Surface Water Monitoring Data All Stations – Parameter Total Phosphorous (P mg/L)

STATION	2014				2015				2016				2017				2018				2019			
	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Pellumbas	0,005		0,033	0,013	0,004	0,025		0,029	0,137	0,053	0,35	0,05	0,07		0,29		0,007	0,035		0,039	0,004	0,027	0,023	
Ura Beshirit	0,26		0,029	0,043	0,012	0,022		0,073	0,166	0,046	0,05	0,063	0,082		0,05		0,074	0,044		0,031	0,007	0,033	0,011	0,01
Ura Sallmone	0,036		0,054	0,02	0,009	0,072		0,094	0,13	0,055	0,042	0,06	0,091		0,058		0,057	0,05		0,059	0,012	0,035	0,016	0,033

Source: National Environment Agency

Table 3. Surface Water Monitoring Data All Stations – Parameter Total Ammonium (NH_4 mg/L)

STATION	2014				2015				2016				2017				2018				2019			
	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Pellumbas	0.13		0.01	0.05	0.00	0.05		0.10	0.02	0.02	1.14	0.03	0.73		0.46		0.01	0.21		0.02	0.08	0.10	0.06	
Ura Beshirit	0.25		0.40	0.02	0.14	0.23		0.86	0.87	0.20	0.14	0.19	1.10		0.10		0.12	1.55		0.11	0.42	0.48	0.44	0.12
Ura Sallmone	0.38		0.15	0.05	0.33	0.12		0.61	0.13	0.42	0.27	2.08	0.38		0.09		0.16	0.34		0.04	0.43	0.23	0.10	0.29

Source: National Environment Agency

Table 5. Surface monitoring results for the Erzeni River Basin in 2019

River Basin	Monitoring station	Parameter (mg/l)						EQS
		DO	BOD_5	NH_4	NO_2	NO_3	P-Tot	
Erzeni	Sallmone - 3	7,2	6	0,25	0,05	0,6	0,09	III
	Beshiri Bridge - 2	7,8	4	0,38	0,04	0,4	0,08	III
	Pellumbas - 1	9,5	3	0,05	0,01	0,3	0,07	II

Source: National Environment Agency (www.akm.gov.al)

The levels of BOD_5 (Figure 1) concentrations in the Erzeni River exceed the limit of good quality in all stations except for the spring period. The concentration of BOD_5 indicates biological pollution and moderate quality of the river that can be attributed to discharges from urban wastewater, and farm effluents. Results of the monitoring for the year 2019 are shown in Table 5.

The content of dissolved oxygen in the waters of Erzeni is of high quality (Class I). The highest concentration of DO is measured in Pellumbas with 9.5 mg/l.

NH_4, NO_3, NO_2, and P-total measured in the river basin are within the EQSs indicating that the water is of good quality. The only exception is the NH_4 concentration at the Beshiri station, which indicates a "moderate" quality of water (Class III).

The levels of BOD_5 concentrations in the Drini River increase gradually from Pellumbas (where indicate good quality of water) to Beshiri and Rrogozhine clearly indicating a moderate chemical and biological quality of the river that could be attributed to discharges from wastewater, industrial effluents, and agricultural run-off.

The measurements indicate a river with water quality that is generally of moderate quality, except for the Pellumbas station which shows good quality status. Based on the above results, the status of Erzeni river waters can be classified overall as 'moderate' quality (Class III) waters. The monitoring results indicate the presence of discharges of industrial and urban wastewater and possibly agricultural run-off.

2. METHODOLOGY

The WFD requires the systematic identification of significant pressures on a river's water quality from point sources of pollution, diffuse sources of pollution, modifications of flow regimes through abstractions or regulation and morphological alterations, as well as any other pressures. 'Significant' means that the pressure contributes to an impact that may result in failing to meet the WFD objective of not having at least "good status". In some cases, the pressure from several drivers may in combination be significant.

Conventionally pressures and impacts occur either at diffuse scale or point scale. Diffuse pressures e.g., nitrate pollution from agriculture e.g., over-abstraction of groundwater - may require general environmental policies or management strategies that apply over a wider area (e.g., a sub-basin or aquifer). Conversely, point pressures such as wastewater discharges or hydropower outflows may require specific actions for individual waterbodies, although correctly determined and enforced higher-level policies should in theory prevent the need for later remedial specific measures.

The pressure assessment and resultant status are central to understanding and quantifying the gaps between environmental objectives and the current state of waterbodies in the river basin.

The assessment is necessarily a mixture of analytical and descriptive criteria depending on the level of data available. Whereas assessment of waterbody status can be a reasonably simple exercise by comparison against standards based on a single analytical sample, assessment of pressures is more complex, because *a)* pressures are typically more diffuse and harder to measure *b)* different pressures combine in complex ways to influence a water body's status.

Urbanization, industrial development, agriculture, energy production, the presence of hot spots, and urban and rural wastewater discharge are regarded as the main sources of pollution. A useful interim approach is to adopt the standard reporting procedures and codified enumeration lists set out by the WISE guidance [4] [5] which provides an "overview approach".

The logic and the methodology behind characterizing water bodies and introducing parameter limit values for the classification of ecological status for surface water and chemical status for groundwater are among others intended for making risk assessments. The risk assessment is done to identify surface water bodies at risk of not achieving at least good environmental ecological or chemical status. The methodology is to compare measured parameter values from ongoing monitoring programmes with parameter limit values applied for good environmental or chemical status. In this comparison, the parameter with the lowest quality classification is decisive for the classification of the whole water body.

3. RESULTS AND DISCUSSIONS

Urban development is a source of main points found in organic pollution that poses pressures on the water resources of the Erzeni river basin. In 2019 in the Erzeni River Basin there are a total of 3 Water Companies responsible for water supply and water services.

Table 6. Water Service Provision in the Erzeni Basin, 2019

Municipality	Population (2019)	WSS Company	Water Supply Coverage (%)	Sewerage Connection Coverage (%)	Population connected to a WWTP (%)
Durrës	190.059	Durres UK Sh.A	87,8	49,87	49,9
Kavajë	40.094	Kavaje UK Sh.A	64,91	25,72	33,4
Rrogozhinë	22.148	Rrogozhine UK Sh.A	54,17	11,38	0,0
Shijak	36.710	Bashkia Shijak	70,9	37,2	0,0
TOTAL	**289.011**		**79,9%**	**42,0%**	**37,4**

Source: National Agency for Sewerage, Infrastructure and Waste; INSTAT

The rate of population covered with supply services varies from 54% for Rrogozhine to 88% for Durres Municipality. All the Municipalities of the Basin have sewerage connections, but only Durres Municipality has a WWTP. This means that, except for Durres, wastewater is collected in public sewers and/or septic tanks and then released into the environment without receiving treatment. The main municipal outfalls have been identified by AMBU[6] (see Table 7).

[4] The approach adopted in the new template for RBMPs in Albania is to closely align with WISE reporting requirements in terms of feature classes and attributes. This focuses data collection only on what is needed for WISE and EIONET reporting and orientates the NWRC data structures to be broadly aligned with WFD outputs.

[5] Water Information System for Europe – WISE GIS Guidance – on the reporting of spatial data to WISE, v 6.0.6, 2016.

[6] Agency for Management of Water Resources

Table 7. Municipal outfalls

Municipality	WSS Company	Municipal Outfall
Kamëz	Kamez UK Sh.A	4 outfall points along the Tiranë River
Krujë	Kruje UK Sh.A	2 outfall points along the Perroi Mzeze branch of the river ishem 1 outfall at Bidrit stream 3 outfall points at Bërdharit stream 1 outfall at Gjolës River
Tiranë	Tirane UK Sh.A	38 outfall points along the Lanë River 1 outfall point at Paskuqanit stream, a branch of Lane River 2 outfall points along the Gjeroskess, a branch of Lane River
Vorë	Vore UK Sh.A	2 outfall points along the Vores stream branch of Lane River

Source: Agency of Water Resources Management

The pollution load deriving from urban waste waters can be determined (see Table 8) using the following unit values for 1 PE[7]:

- Biochemical Oxygen Demand (BOD_5) = 60g/person/day[8].
- Total Nitrogen (TN) = 11 g/person/day.
- Total Phosphorus (TP) = 2.8 g/person/day.

The amount of Tot-P, Tot-N, and BOD5 and water consumption within the basin can be calculated as shown in Table 8.

Table 8. The daily and yearly load from 1 PE and the load from 896,275 people living within the basin

1 PE	Day	Year	896,275 PE/year
Tot-P	2.8 g	1.0 kg	896 t
Tot-N	11 g	4.0 kg	3585 t
BOD^5	60 g	21.9 kg	19628 t

Source: Own research

Industrial activities are point sources of pollution that place constant pressure on the water resources of the river basin. These mainly include:

- *The manufacturing industry* is the revenue leader sector and includes production activities of cement and construction materials; metals (iron and ferrochrome alloys); leather goods; textile goods and footwear; and aluminum for construction. 11 large industrial installations operate in the basin with Class A (IPPC compliant) permit[9] (Table 9).

However, there are no official data on the amounts of water used by this sector, nor for the quantity/quality of discharged wastewater.

7 PE: Person Equivalent. Common applied values in EU countries.

8 The estimated organic load of 60 g/person/day corresponds to one population equivalent (PE), as defined in the Directive 91/271/EEC.

9 The current Albanian permitting system in relation to environment protection is established by the Law on Environmental Permitting No. 10488 Dated 14.7.2011, which provides the basic principles for the environmental permitting process. The Law establishes a three-tier system for permits of installations and activities, namely: Class A, Class B, and Class C Environmental Permit. These three are distinguished from each other by the thresholds of industrial activity, production, andcapacity. A Class A permit shall take into account the environmental performance of the installation or the activities as a whole. The permit set emission limit values for pollutants, according to Best Available Techniques. *The Class A permit is aligned to the EU IPPC permit.*

Table 9. Large industrial installations within Erzeni River Basin

Municipality	Product or processing	Activity by EU Sector
Durres	Collection, recycling, and melting of batteries for lead production	Waste, Metallurgy
Durres	Sugar production plant	Misc.
Durres	Production of cast aluminum	Metallurgy
Durres	Bricks factory	Mineral
Durres	Recycling of lead from used batteries	Metallurgy
Durres	Plant for recycling scrap metal	Metallurgy
Durres	Factory for the processing of the medicinal plants	Chemistry
Durres	Tires and plastic materials pyrolysis	Chemistry
Durres	Cement production	Mineral
Durres	Processing of organic fertilizers	Misc.
Durres	Batteries recycling	Waste, Metallurgy

Source: Own Research

Agriculture and farming activities are diffuse sources of organic and inorganic pollution (mainly BOD, nitrogen, and phosphorus) that place constant pressure on the water resources of the river basin as they may cause deoxygenation and eutrophication of surface waters and contribute to declining fish stocks, and a loss of biodiversity.

Agriculture run-off also remains a challenge for river pollution as it is a major contributor to the eutrophication of freshwater bodies. The effects of agriculture (and animal farming) on the status of surface water can be separated by point and diffuse sources.

Regarding the point sources, there are discharges of wastewater from livestock farms and slaughterhouses. The table below (Table 10) prides an overview of the farming and food processing installations under Class A (IPPC compliant) permit requirements. However, no actual information is available on the loads from these installations.

Table 10. Large livestock farms and slaughterhouses by basin

Basin	District	Product or processing
Erzeni	**Durres**	Chick farm and eggs production
		Pigs farm
		Chick farm and eggs production
		Plant for livestock food production
		Chick farm and eggs production

Source: Own Research

Mineral fertilizers, such as nitrogen (N) and phosphorus (P), are widely used in agriculture to optimize production. They are important nutrients that are absorbed from the soil by plants for their growth. A surplus of nitrogen and phosphorus can, however, lead to environmental pollution like the eutrophication of surface water.

Albania's mineral fertilizer consumption fluctuated substantially in recent years, it tended to increase through the 2002 - 2019 period and was 126.14 kg/ha of arable land.[10]

The yearly fertilizer consumption in the Erzeni basin is estimated at 4,812 ton/ha. Based on the information on fertilizers usage it is possible to estimate the usage of different nitrogenous and phosphorus fertilizers in the river basin as shown in Table 11.

[10] Source: https://data.worldbank.org/indicator/AG.CON.FERT.ZS?locations=AL

The main pollutants related to animal farming are BOD, nitrogen, and phosphorus. The estimation of the pollution loads can be made by knowing the livestock's number, based on emission factors considering local experience and data reported in the literature.[11] Based on livestock structure data from the Albanian Institute of Statistics (INSTAT), the total load for N and P from animals in the Erzeni basin can be estimated as follows (Table 12). The total amount of nitrogen and phosphorus generated or applied from the above sources can be summarized as shown in Table 13.

Table 11. N and P from fertilizers – Nitrogen and Phosphorus fertilizer use (a ton of fertilizer and an equivalent ton of N and P), 2019

Basin Erzeni	
Urea Nitrogen (tonnes)	1.877
containing 46% N (tonnes)	863
Ammonium Nitrate (tonnes)	1.732
containing 34.5% N (tonnes)	598
Tonnes of Nitrogen applied	**1.461**
Super Phosphate (tonnes)	1.203
containing 7.07% P(tonnes)	85
Total Phosphorus applied	**85**

Source: Own Research

Table 12. Estimate load of N and P from livestock

Animal Category	**Erzeni**	
	N load (ton/year)	**P load (ton/year)**
Cattle	1854	206
Sheep	592	101
Pigs	123	36
Equidae	17	4
Poultry	95	63
Turkeys	8	4
Total	**2690**	**414**

Source: Own Research

Table 13. The total amount of nitrogen and phosphorus generated or applied within Erzeni Basin area

	Total N load (t/year)	**Total P load (t/year)**
Total from fertilizer (tonnes)	1.461	85
Total from livestock (tonnes)	2.690	414
Total	*4.151*	*499*

Source: Own Research

[11] Data on livestock manure characteristics presented are obtained by combining a wide base of published information on livestock manure production and characterization. Actual values vary due to differences in animal diet, age, usage, productivity and management. Whenever actual sample analyses can be performed, such information should be considered in lieu of the mean values presented here.

Fresh manure characteristics per 1000 kg live animal mass per day

Parameter	**Unit**	**Animal Type**						
		Cattle	**Cows**	**Sheep / goats**	**Swine**	**Equines**	**Poultry**	**Turkey**
Total N	**Kg**	0,45	0,34	0,41	0,48	0,3	0,33	0,52
Total P	**Kg**	0,05	0,092	0,07	0,14	0,07	0,22	0,23

The pollution by livestock in each of the basins can be calculated by considering a typical live animal mass of cattle 450 kg; swine 150 kg; sheep/goat 50 kg; horse 200 kg; poultry 0.8 kg; turkey 3.5 kg.

Solid Waste Disposal. Random disposal of waste on land and along watercourses is common and represents a major problem in the basin. Waste disposal might more appropriately be addressed as a source of diffuse pollution.

Dumping in poorly managed landfills is the main method of municipal solid waste disposal. These sites lack the necessary infrastructure or engineering provisions to collect and contain landfill leachate and gas.

Five dumpsites exist at Rrogozhina (located on the banks of a stream), at Manez (located at the end of a very poor dirt track although unusually for Albania the site is fenced), at Sukth (located on flat terrain adjacent to a small irrigation type canal), at Shijak (located next to a graveyard at the end of a very poor access track), and at Durres, which is a large site on flat wetland terrain.

4. CONCLUSION

The table below (Table 14) presents a final register of the identified pressures, an estimation of the waterbody's status, and an estimation of the waterbodies at risk of failing the environmental objectives.

Available monitoring data and assessment criteria do not yet allow for a comprehensive assessment of the environmental state of water bodies in the Erzeni basin. Generally, Erzeni is moderately polluted largely due to the discharges of untreated wastewater and agriculture activities. This implies that the river will not comply with the WFD criteria for "good" status.

Table 14. Pressure type identified and quality status analysis

PRESSURE TYPE				***WATER QUALITY STATUS*** *(Yearly average concentrations not meeting the Albanian thresholds for "Good" status)*						***RISK ASSESSMENT***
POINT PRESSURE	DIFFUSE PRESSURE	ABSTRACTION PRESSURE	Hydrological Alteration	BOD_5	NH_4	NO_2	NO_3	Ptot	OVERALL STATUS	RISK LEVEL
Urban Wastewater	Agriculture Runoff	Agriculture	Gravel extraction	x					Moderate	Probably at risk
Industrial Pollution	Mining Contamination									
Solid waste disposal										
Aquaculture Farm Fish										

Source: Own Research

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