AN OVERVIEW ON SOME SELECTED ENVIRONMENTAL POLLUTION INDICATORS IN THE ISHMI-ERZEN WATER BASIN AND THE NEED FOR PHARMACEUTICAL RESIDUES MONITORING

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Abstract

National Environment Agency's Environmental Status Reports have classified the Ishmi-Erzen water basin in Class V –Bad status- during the period 2018 - 2022. This classification highlights significant concerns about water quality due to population growth and inadequate water treatment infrastructure. This study identifies the potential hotspots data from ten stationary monitoring points along the basin, collected over several years (2018-2022), to identify potential hotspots for organic contaminants in the river basin. The analysis focuses on BOD_5, ammonia, nitrates, nitrites, and phosphorus content. Key findings have indicated the highest pollution levels in some sampling sites. One of them showed consistently high pollution levels, throughout the monitoring period. Additionally, another sampling site revealed significant pollution only in BOD_5 and ammonia. These results suggest that these areas are critical hotspots or further study due to their potential impact on public health and aquatic ecosystems. Changes in dissolved oxygen (DO) and fluctuations in other environmental pollution parameters indicate various pollution sources, requiring ongoing attention to address water pollution effectively. This paper aims to evaluate the analytical data from official environmental reports to provide an overall overview on the environmental water basins hotspots, the most prevalent pollutants and indicators to better set up the methodology, determine the critical sampling sites for eventual pharmaceutical residues monitoring and findings. The analysis of the data published from the National Environmental

Agency Annual Reports will serve to outline our monitoring program on some pharmaceutical drugs present in environment, water basins, in particular.

Key words: *water basin, water quality, monitoring stations, environmental pollution indicators.*

Përmbledhje

Raportet e Agjencisë Kombëtare të Mjedisit e kanë klasifikuar basenin Ishëm-Erzen në Klasën V–'Gjendje e keqe' nga viti 2018 - 2022. Ky klasifikim nxjerr në pah shqetësime të rëndësishme për cilësinë e ujit për shkak të rritjes së popullsisë dhe infrastrukturës së papërshtatshme të trajtimit të ujit. Ky studim përdor të dhëna nga dhjetë pika stacionare monitorimi për gjatë basenit, të mbledhura gjatë disa viteve, për të identifikuar hotspote të mundshme për ndotës organikë përgjatë basenit. Punimi fokusohet në krahasimin ndër vite të parametrave si: NBO_5, amoniak, nitrate, nitrite, ortofosfate dhe fosfor total. Gjetjet kryesore kanë treguar nivelet më të larta të ndotjes në disa vende të kampionimit. Njëra prej tyre ka shfaqur nivele të larta ndotjeje të vazhdueshme gjatë gjithë periudhës së monitorimit. Për më tepër, një vend tjetër për marrjen e mostrave zbuloi ndotje të konsiderueshme vetëm në BOD5 dhe amoniak. Këto rezultate sugjerojnë se këto zona janë pika kritike për studime të mëtejshme për shkak të ndikimit të tyre të mundshëm në shëndetin publik dhe ekosistemet ujore. Ndryshimet në oksigjenin e tretur (DO) dhe luhatjet në parametrat e tjerë të ndotjes mjedisore tregojnë burime të ndryshme ndotjeje, duke tërhequr vëmendjen e vazhdueshme për të trajtuar në mënyrë efektive ujrat e ndotur. Ky punim synon të vlerësojë të dhënat analitike nga raportet zyrtare mjedisore për të pasur një pasqyrë të përgjithshme mbi pikat e nxehta të baseneve ujore mjedisore dhe ndotësit dhe treguesit më të përhapur për të vendosur më mire metodologjinë e studimit për monitorimin e mbetjeve farmaceutike duke përcaktuar pikat kritike të marrjes së mostrave. Analiza e të dhënave të publikuara nga Raporte të Gjendjes Mjedisore Vjetore të Agjencisë Kombëtare të Mjedisit do të shërbejnë për të përvijuar programin tonë të monitorimit të disa barnave farmaceutike apo mbetjevete tyre të pranishme në mjedis dhe në basenet ujore, në veçanti.

Fjalët kyçe: *basen ujor, cilësia e ujit, stacion monitorimi, indikatorët e ndotjes mjedisore.*

Introduction

Over the last decades, Tirana has experienced a significant increase in population. Increased population density has led to a higher demand for water resources *(Joseph et al., 2017)* and considerable wastewater discharges, contributing to the degradation of water quality in the river basins passing through. Urban runoff is another important source of pollution. During rainfall events, pollutants from roads, industrial areas and residential areas are washed into the river system. These pollutants include heavy metals, hydrocarbons, nutrients and other hazardous substances that can adversely affect aquatic ecosystems and human health *(Yang et al., 2021).* Among the most present pollutants in the water basins in recent years are pharmaceutical medications *(Wilkinson et al., 2022)*. Such drugs often enter in water basins through sewage discharges, waste from hospitals, and runoff from agriculture. Many of these pharmaceutical compounds are not biodegradable and can remain present in the environment for long periods of time, causing persistent pollution. The presence of medicines in surface waters can affect the health of aquatic organisms, lead to the development of antibiotic resistance, and have unforeseen consequences for food chains. For this reason, the monitoring and analysis of these substances are essential to understand and manage their impacts, to develop good strategies for the management of pharmaceutical waste, and to protect ecological integrity and public health.

The Ishmi-Erzen Basin, located in central Albania, is a critical watershed that supports a wide range of ecosystems and serves as an important source of water for agriculture, industry, and domestic uses. Different studies have been done over the years analysing the Ishmi-Erzen water basin quality *(Kucaj et al., 2022), (Nuro et al., 2017).* The monitoring of chemical parameters within this basin has taken on a special importance due to the growing concerns regarding the degradation of water quality from industries, urbanization and insufficient wastewater management.

The basin is under constant pressure from anthropogenic activities, including potential discharges from pharmaceutical industries, wastewater from urban water treatment plants, and diffuse pollution from agricultural activities. For this reason, monitoring the water quality in the Ishmi-Erzen basin is important to understand the impact of human activities on the aquatic environment and to assess the level of pollution from organic pollutants. Taking into consideration all the parameters, it is estimated that at the reference stations the rivers are clean, while passing through residential areas, the impact of wastewater which are directly discharged untreated, brings high pollution, classifying the Ishmi- Erzen basin in Class V – Bad condition. (*National Environmental Assessment*, 2022)

Methodology

The purpose of this article is to locate the points of great interest for further analysis on the presence of pharmaceutical pollution in the Ishmi-Erzen basin, based on the data obtained from the environmental reports published over the years on the quality of the basin. To achieve this objective, we have analyzed the data obtained from the National Environment Agency (NEA) Annual Environmental Status Reports during 2018-2022. We have extracted and analyzed the parameters for the Ishmi-Erzen water basin as this will be the target zone of the pharmaceutical drugs residues monitoring. The samples have been taken and analyzed by NEA specialists and were presented in the Environmental Status Reports 2018-2022 *(NEA 2018, NEA 2019, NEA 2020, NEA 2021, NEA 2022)*. Over the years, the following parameters were measured four times in a year (once in each season): dissolved oxygen (DO), biochemical oxygen demand (BOD_5), nitrite (NO_2), nitrate (NO_3), total ammonium (NH_4), total phosphorus (P_{Total}) and orthophosphate (PO_4). NEA's laboratory is accredited for analyzing the above-mentioned parameters with standard ISO methods. The data displays the analytical results for samples taken in 10 stationary points (T1, T2, L1, L2, Ish1, Ish2, sh3, Er1, Er2, Er3) determined by the agency itself. The coordinates of the stationary points are given in Table 1 as well as shown in Figure 1.

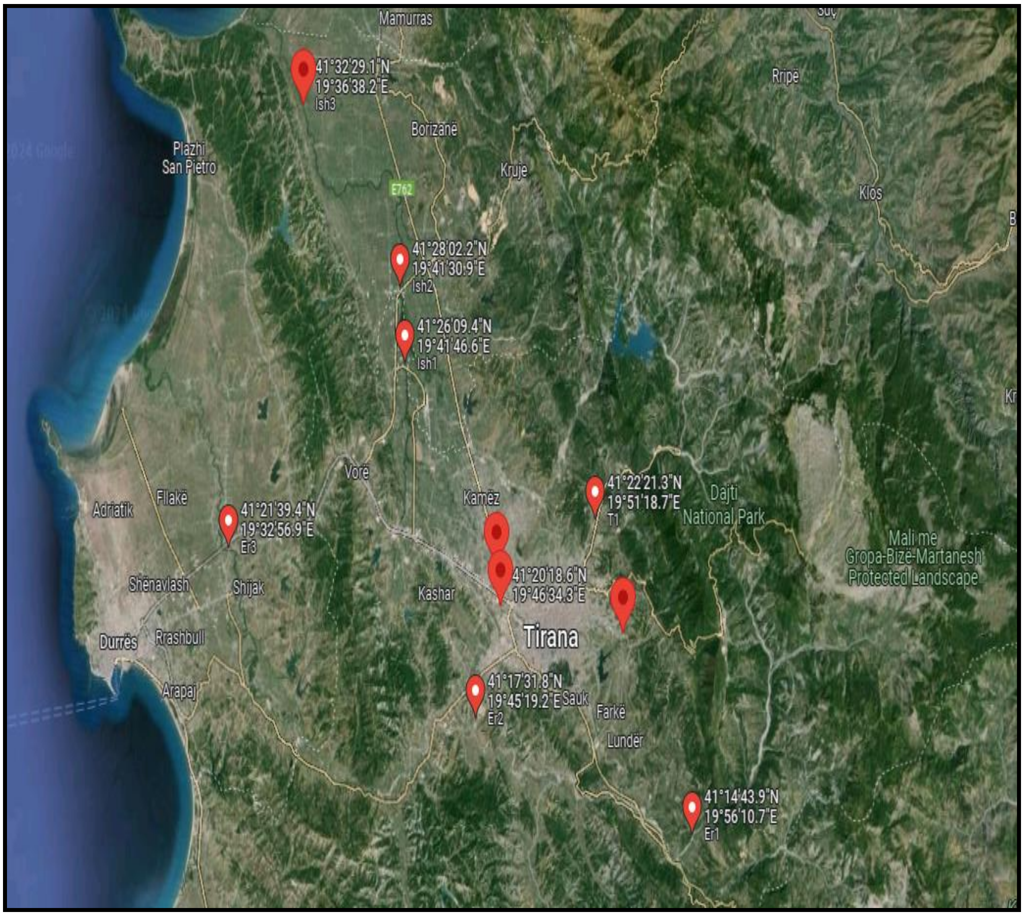


Figure 1. Stationary points taken in consideration

Table 1. Stationary points taken into consideration in the study

Stationary points	**Name of the river**	**Geographical coordinates**
T1	The river of Tirana	N41.372595 E19.855204

T2	The river of Tirana	N41.354077 E19.773338
L1	Lana River	N41.3293 E19.8788
L2	Lana River	N41.3385 E19.7762
Ish1	Ishmi River	N41.435932 E19.696267
Ish2	Ishmi River	N41.467270 E19.691924
Ish3	Ishmi River	N41.541421 E19.610609
Er1	Erzen River	N41.245533 E19.936300
Er2	Erzen River	N41.292176 E19.755325
Er3	Erzen River	N41.360944 E19.549134

Source: Environmental Status Report, NEA, 2018-2022

Table 2 presents the river quality classification criteria based on their chemical parameters.

Table 2. Classification scheme for rivers quality conditions

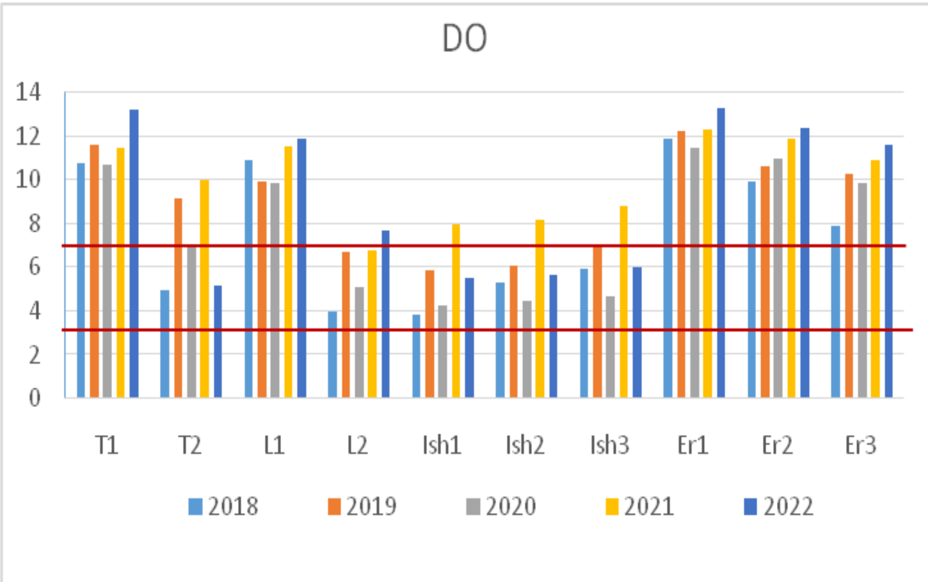
Parameters	**Unit**	**High Status (I)**	**Good Status (II)**	**Moderate Status (III)**	**Poor Status (IV)**	**Bad Status (V)**
Dissolved oxygen	mg/l	>7	>6	>5	>4	<3
BOD_5	mg/l	<2	<3,5	<7	<18	>18
pH (acid)		>6,5	>6			
pH(alkaline)		<8,5	<9			
NH_4	mg/l	<0,05	<0,3	<0,6	<1,5	>1,5
NO_2	mg/l	<0,01	<0,06	<0,12	<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: NEA ESR 2018-2022

Results and discussion

In this paragraph we have presented and analyzed the most significant analytical findings for the main water quality parameters. The values presented in the following graphs are extracted from the NEA Annual Environmental Status Reports for 2018-2022 period and they have been elaborated to make the comparison during the monitoring years to have a clear and overall scenario of the water pollution and the predominant pollutants for the target zone. The values are the average results for each year to show the trends in river quality conditions.

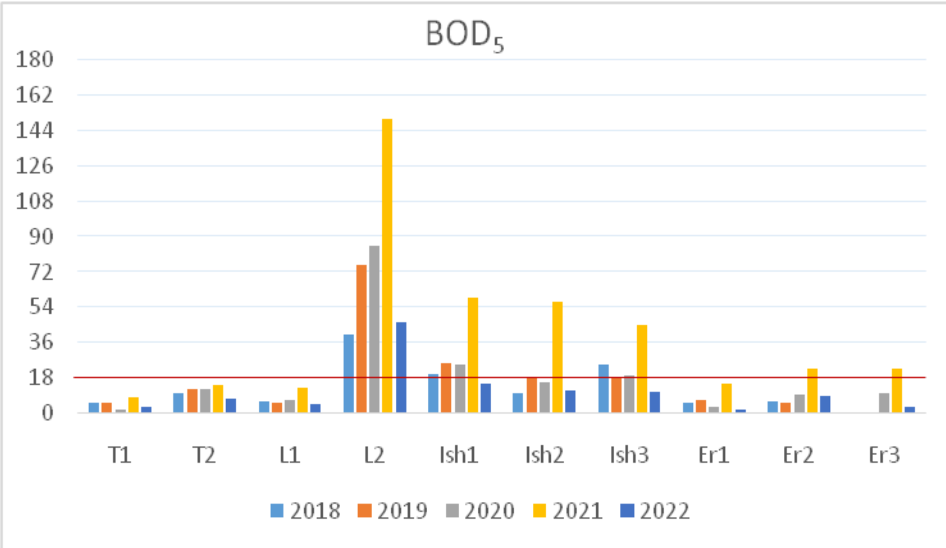
Regarding the first parameter DO, stationary points L2 and Ish3 have shown the dissolved oxygen values in water in 2022, 7.67 mg/l and 6.04 mg/l, respectively. These values fit the limits of good and high status of water quality in most of the monitoring years. On the other hand, stationary point T1 has a higher value of dissolved oxygen in water at 2022, with only 13.22 mg/l, which is among the highest values in all monitoring years. However, compared to other stationary points, T1 can be considered in a relatively better condition.



Source: Own elaboration of the data extracted from ESR (2018-2022)

***Figure* 1.** DO concentrations over the years

Graph 2 indicates that the locations L2, Ish1, Ish2, and Ish3 consistently exhibit poor status due to high BOD_5 concentrations, which is a sign of severe and ongoing organic pollution. Er3 shows the most significant improvement, transitioning from a bad status in 2021 to a good status in 2022.

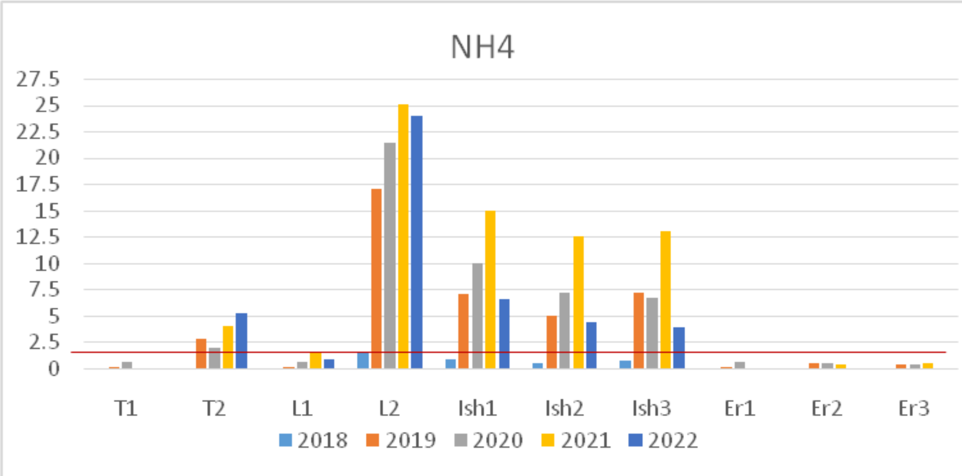


Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 2. BOD_5 concentrations over the years

Other notable improvements include T1**,** L1, and Er1, which also achieved good status in 2022. However, sites like T2**,** Ish1, Ish2, and Ish3 still require continued efforts to reduce organic pollution and improve water quality.

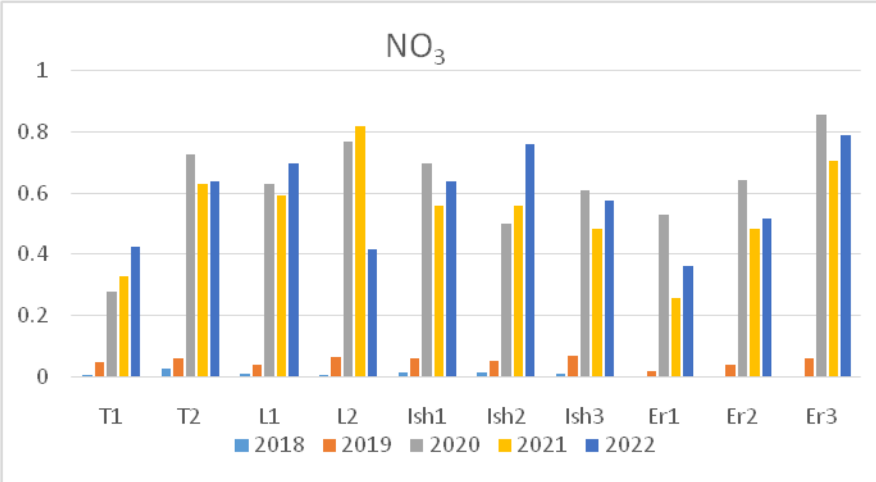
The poor condition of ammonium levels at various stationary stations during the period of 2018-2022 is highlighted in graph 3. Stations T2, L2, Ish1, Ish2, and Ish3 display high ammonium levels, which indicate a poor status throughout the 5-year period. Stations T1 and L1 show lower NH_4 levels and are in better condition, with some years demonstrating a high-water quality status. Thus, these two areas stand out as being more acceptable compared to the others.



Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 3. NH_4 concentrations over the years

The data in Graph 4 indicates that there are different trends in nitrate levels across different stationary points regarding the nitrate content. In all stationing points except T1 and Ish2 fluctuation in nitrate levels over the years are evident, but they stabilized by 2021 with a slight increase in 2022.

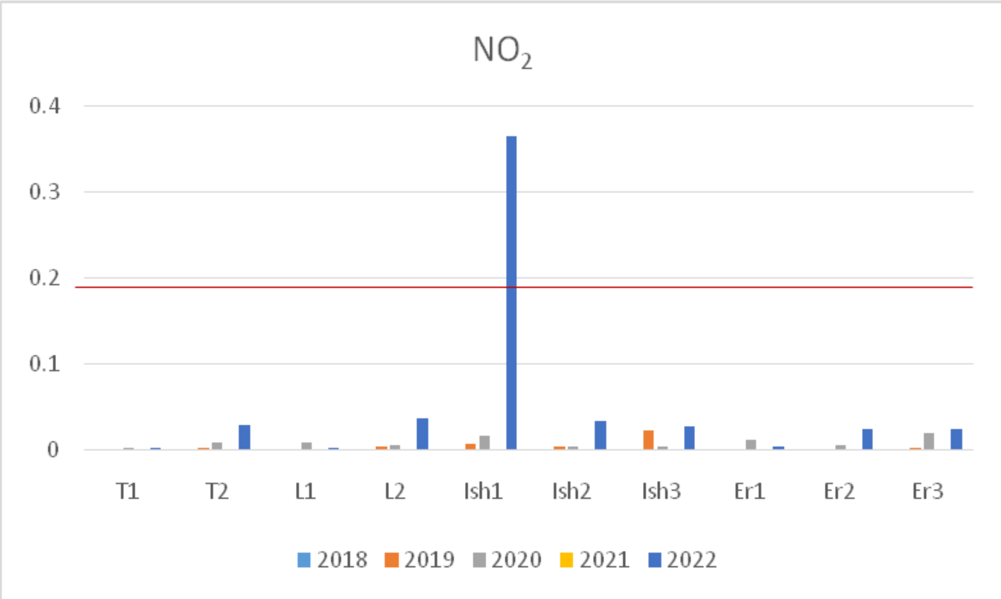


Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 4. NO_3 concentrations over the years

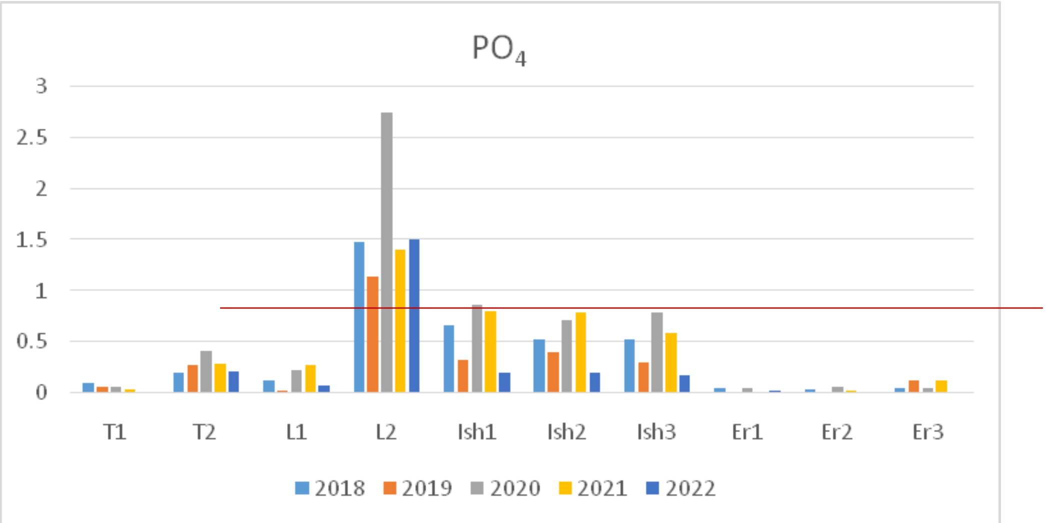
T2 showed a consistent increase in nitrate levels, particularly notable in 2020, with a decrease in 2021 followed by another increase in 2022. In L1, there was a continuous increase in nitrate levels, especially significant by 2020, with a slight decrease in 2021 but an increase again in 2022. L2 had high nitrate levels in 2021, although there was a reduction in 2022, it still remained above defined limits, suggesting persistent pollution. All the data for this parameter show that relating to the nitrate level, all the stationary points show a good status in that 5-year gap.

In the given Graph 5, the nitrite values for stationary points T1, T2, L1, L2, Ish1, Ish2, Ish3, Er1, Er2 and Er3 for the years from 2018 to 2022 are presented. In 2018, some of the points showed values of small amounts of nitrites, while in 2019, there was a significant increase for some of them. However, some values are missing for 2018 and 2020 for some stationary points, while in 2021, again some of them showed increased values. The values obtained for the most of the points have changed significantly in 2022, with some noticeable increases, as is the case for points Ish1, Ish3, Er2, and Er3, which show a decline in the quality of the water.



Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 5. NO_2 concentrations over the years

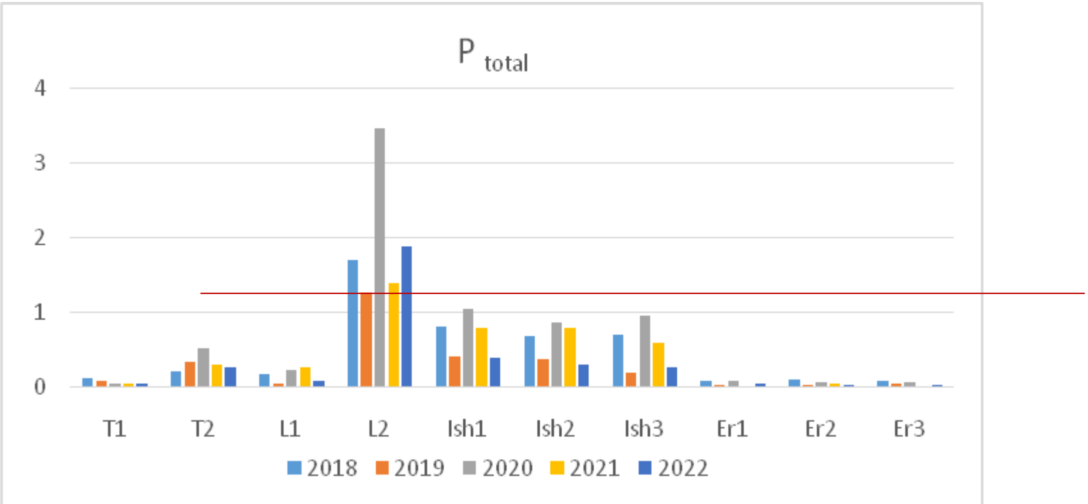


Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 6. PO_4 concentrations over the years

In Graph 6, phosphorus as orthophosphate ion (PO_4) values are presented for the periods from 2018 to 2022 for the stationary points T1, T2, L1, L2, Ish1, Ish2, Ish3, Er1, Er2 and Er3. In 2018, most of the stationary points have shown high phosphorus values, ranking them in the poor status category (V). While several of these values have decreased in 2019 and some remained high, the majority are still classified for their low quality.

In the following years, for some of these points there was an increasing trend of phosphorus values until 2020, jumping the threshold of poor status for some of them, where point L2 showed the highest value at 2.75 mg/l in 2020. However, in 2021, values have decreased again for most stationary points, while some still remain in the poor status category. In 2022, some points have shown significant improvements, jumping up to good (II) or medium (III) status, but some still remain in the poor status category.



Source: Own elaboration of the data extracted from ESR (2018-2022)

Figure 7. P_{Total} concentrations over the years

The values of Total-P for stationary points T1, T2, L1, L2, Ish1, Ish2, Ish3, Er1, Er2 and Er3 for the period from 2018 to 2022 are shown in graph 7. In 2018, most stationary points showed high values of total phosphorus, ranked in the category of poor status. In 2019, values for some of the points decreased, but still remained at the limits of poor status for most of them. In 2020, the total phosphorus values for some of the points increased, passing to poor status for some of them, but the highest value was observed at point L2, at a concentration of 3.47 mg/l. However, in 2021, for some of these points the values decreased again, while for some they were assessed at the limits of poor status. Despite significant improvements in 2022, some points have dropped to good (II) or medium (III) status, while others are still in the poor status category.

The analysis of environmental monitoring in the 5-year period showed that the most consistent problematic parameters included high levels of BOD_5 and other parameters such as nitrogen, orthophosphates and total phosphorus. These findings guided us to set up a reasonable and scientifically based sampling plan defining meaningful and logical control points to perform a more detailed environmental analyses and assessment, including additional analyses such as COD and the presence of pharmaceutical drugs residues.

As they are partly non-biodegradable and show a tendency for bio concentration it's an imperative responsibility to draw attention to the persistence and/or presence of these chemicals in the environment matrices. As the monitoring reports have not included the residues of pharmaceutical and veterinary drugs residues in surface water basins, it is an objective of our further research to contribute to an overall environmental water pollution assessment as an innovation and orientation of the community and state inspectorates in the identification of "hotspots" for these pollutants. This approach will help improve mapping of sampling sites and analysis of environmental parameters, as well as initiate specific monitoring for pharmaceutical pollutants in Ishmi-Erzen water basin.

Conclusions and recommendations

Water resources quantity and quality remains a global concern, but its susceptibility by many natural and anthropogenic factors has made an ongoing necessity to monitor its main parameters to guarantee sustainability for the present and future generations to come. The Annual Environmental Status Reports from the NEA reveal the current situation of the water body systems and their quality status. These data serve as a red flag to draw attention to the governmental institutions and community to take immediate measures to preserve this natural wealth.

The assessment and monitoring of the river basins quality being a priority issue, should be further extended to other environmental contaminants such as pharmaceutical drugs residues in aquatic systems especially during these post pandemic years. The analysis of the data shows that important data are missing for some other pollution indicators in water body systems such as pharmaceutical drug residues or medicines. Their monitoring should start and continuously be monitored as some relevant scientific data confirm their persistence and bio concentration in the aqua systems having a specific impact in human and aquatic organisms. This monitoring should be correlated with the source, their fate and transport in the environment to prevent or minimize their entrance route. To succeed in this objective, some preliminary data should be gathered including the use and disposal of medicines and pharmaceutical drug residues in the environment.

In any case, the identification of the pollution sources to minimize and/or prevent the entry of pollutants into water bodies remains a matter of high priority. In the analysis of water quality parameters, it is evident that some of these parameters, such as dissolved oxygen (DO) levels, require special attention in relation to the presence of medications. For example, the use of certain medications can reduce the DO level in the water, creating unfavourable conditions for the life of aquatic organisms.

At the same time, increased levels of oxidative biodegradation (BOD_5) can result from the decomposition of medications by microorganisms, bringing organic pollution in the water. In terms of ammonium, presence of certain medicines can contribute to an increased ammonia levels in water, creating new challenges for aquatic ecosystems. Also, the content of phosphorus and nitrogen in water can change from the presence of medicine, creating different effects on the quality and ecology of natural waters. This implies the need for a holistic approach to the management of water pollution, including monitoring the effects of the presence of medicines in the environment and implementing measures to reduce the negative impact.

In conclusion, the analysis of water quality data for the period 2018-2022 revealed that as you approach residential areas, the level of pollution increases. Station L2 recorded high variability in BOD_5 levels, showing a significant reduction in recent years, while high levels of ammonium in L2 and Ish1 suggest possible sources of organic contamination. The high levels of phosphorus in L2 and Ish1 present a potential pollution problem from agricultural fertilizers and domestic waste. It is worth to say L2 and Ish1 should be monitored and analysed for medicines and/or veterinary drug residues potentially present in these stationary points. These points will be our study target for their monitoring.

To make a more in-depth analysis of the organic pollutants in the water body systems, it would be suggested to carry out further analyses mainly in the most problematic stationary points which are closer to the inhabited centres of the Tirana city. It is also suggested that the measured and presented values be reflected according to the seasonal distribution to better determine the sampling frequency to obtain more reliable and valid results. It would also be advisable to include the analysis of veterinary medications and drugs in monitoring, considering their negative impact on the ecosystem.

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