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# The Impact of Wastewater on the Quality of Water of Nerodime River

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**ABSTRACT**

This study aimed to evaluate the discharge waters in the Nerodime River and the impact of the seasons on the quality of the surface waters in the Nerodime River. Research data were collected at six locations along the Nerodime River in three seasons of 2021. During this research, 14 physico-chemical parameters and total coliform bacteria were analyzed. Based on the study results, most of the tested parameters are above the maximum values allowed in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012). CCA (canonical correspondence analysis) indicates that Total coliform bacteria were in positive correlation with turbidity, color, chlorides, sulphates, and total coliform bacteria. This Poor quality is a consequence of anthropogenic activities including industrial water use and sewage discharge.

**Keywords:** pollution, wastewater, treatment, quality, anthropogenic activities.

## INTRODUCTION

Water is a universal solvent that man needs for a variety of activities, and the two fundamental issues that man faces are the amount and quality of water (Oluyemi et al., 2010). Water is essential to both man and the entire ecology. One of the most urgent environmental and sustainability challenges of the twenty-first century is the availability and quality of freshwater. Freshwater is valuable because life cannot exist without it, and human activities have a significant influence on the quantity and quality of freshwater accessible (Udiba et al., 2014; Al Chalabi et al., 2022). Heavy metals, pesticides, detergents, petroleum products, and other materials, as well as industrial, agricultural, and medical wastes, may have a deleterious influence on public health and biodiversity in aquatic environments (Maitera et al., 2010; Osibanjo et al., 2011).

The disposal of untreated and treated wastewater from human sources has polluted surface water bodies, impairing their utility for industrial, drinking, recreational, agricultural, and other uses (Todd et al., 2012; Dreshaj et al., 2022; Rahutami et al., 2022). The dumping of wastewater into surface water endangers the aquatic ecosystem by disrupting natural environmental conditions and exposing aquatic species living in that area to hazardous chemicals (Oyekanmi et al., 2021). The amount of biodegradable organic components that end up in receiving water bodies from inadequately treated wastewater effluents greatly increases the consumption of dissolved oxygen (Khanh & Nam 2022; Hasanawi & Salami 2022; El Ouadrhiri et al., 2022). As a result, as the concentration of dissolved oxygen declines, aquatic species' survival becomes challenging and perhaps dangerous. Furthermore, oil and grease found in wastewater effluents are complex and difficult to break down, and as a result, deposits on the surface of receiving waterbodies, interfere with the photosynthesis of aquatic biota by inhibiting light penetration (Oyekanmi et al., 2019;

Kilian et al., 2022; Indrayanti et al., 2022; Melnyk et al., 2023). As a result, it is critical to collect well-founded information to determine the quality of water and identify the source of contamination, which aids in the successful management of water pollution in freshwater resources (Ustaoglu et al., 2020; Matiyiv et al., 2022; Ougrad et al., 2022).

Water contamination is linked to the development of urbanization, industry, and agricultural drainage (Aboulfotoh & Heikal 2022; Ramadan et al., 2017; Benaissa et al., 2022). One of the most serious risks to surface and groundwater is contamination from sewage (Aboulfotoh & Heikal 2022; Duong et al., 2022; Rizani et al., 2022). Similarly, in the municipality of Ferizaj, where the Nerodime river runs, the primary issue is the non-treatment of sewage from industry and urbanization, which all flows into the river and degrades its quality. According to the research of Bytyqi et al., 2020, the Nerodime River is contaminated with organic pollutants from industry and urbanization, and the presence of plant species with substantial nutrient accumulations is demonstrated. Furthermore, according to Etemi et al., 2020 research in the Gerlic area, which is a research site, there is no existence of living creatures or animal species owing to enormous organic pollution, except for oligochaetes, which are indicators and tolerant of organic pollution. Freshwaters are extremely valuable since, without them, no life can flourish; yet, in today's world, human activities have drastically altered the amount and quality of freshwater (Udiba et al., 2014; Sadiq et al., 2022). Ferizaj is one of the cities in Kosovo with the most industrial growth (PZHK 2017). The municipality's special feature is the Nerodime River Bifurcation, a rare hydrographic phenomenon, where the water of this river divides and runs in two different directions, one towards the Aegean Sea and the other towards the Black Sea (PZHK 2017). This phenomenon is unique to Europe. This means that a part of the waters of the river Nerodime from the source in Jezerc to Upper Nerodime in their natural state can be used for swimming, recreation, and water sports, to raise the low quality of fish and water which then by the common methods of processing (coagulation, sedimentation, filtration, disinfection, etc.) are appropriate for public use, while the rest of the water can be used for watering and industry, except for the food industry (Urban Development Plan of Ferizaj 2008). But from the village Upper Nerodime, respectively Down Nerodime, is impossible to use this water for any kind of activities, without deep treatment, because of pollution which comes from wastewater thrown from the citizens of villages and town Ferizaj who lives near the river Nerodime (KEPA 2007). The city of Ferizaj throws all Ferizaj sewage and untreated industrial wastewater into Nerodime.

## METHODOLOGY

### Location of sample collection

The Nerodime River runs from the Nerodime Mountains to the Upper Nerodime town of Jezerc. Down Nerodime, town Ferizaj turns south, passing through the villages of Varosh, Gerlic, Kaçaniku i Vjeter, Stagove, and Runjeve before reaching Kaçanik and empties into the Lepenci river near the Lime Factory (KEPA 2009). The Nerodime River branch of the Aegean Sea is 41 km long, with a surface area of 228 km$^2$ and it water to Lepenci at an average rate of 2,1 m$^3$/s (KEPA2009).

### Sampling

Water samples were taken at six places along the Nerodime River, including S1: position on the connection with wastewater, S2: position after joining with wastewater, S3: Gerlice, S4: Kaçaniku I Vjeter, S5: Stagove and S6: Kaçanik with a frequency of 4 times/year (Table 1).

Surface water quality parameters, including turbidity (Turb.), color (Co-Pt), free chlorine (F-Cl), pH, ammonium ($NH_4^+$), nitrites ($NO_2^-$), nitrates ($NO_3^-$), total phosphorus (TP), phosphate ($PO_4^{3-}$), conductivity (Cond.), alkalinity (Alk.), chlorides ($Cl^-$), sulphates ($SO_4^{2-}$), and total coliform bacteria (Coliform) were used to assess the

**Table 1**. Coordinates of water sampling in Nerodime river

| Samples | Coordinate X | Coordinate Y |
|---|---|---|
| S1 | 42º 19' 46" N | 21º 11' 26" E |
| S2 | 42º 19' 42" N | 21º 11' 28" E |
| S3 | 42º 19' 24" N | 21º 11' 66" E |
| S4 | 42º 18' 01" N | 21º 13' 46" E |
| S5 | 42º 16' 19" N | 21º 14' 50" E |
| S6 | 42º 13' 49" N | 21º 15' 23" E |

**Note:** S1 – position on the connection with wastewater, S2 – position after joining with wastewater, S3 – Gerlice, S4 – Kaçaniku i Vjeter, S5 – Stagove, S6 – Kaçanik.

water quality and as input in multivariate statistical analysis. Those parameters are presented in Table 2.

### Chemical analysis (tests)

All samples were tested in the laboratories of "The Institute for Public Health", Pristine, and "KUR Pristina", Pristine, Kosova, both accredited according to the requirements of standard ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories, by the General Directorate for Accreditation of Kosovo (DAK). Laboratories were well-equipped and had competent staff. All parameters were tested by Standard Methods for the Examination of Water and Wastewater in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012). A sampling of water is made by standard procedures based on standard ISO 5667-6:2014 water quality – sampling. Bottles filled with river water are closed and entered into the refrigerator, then sent to the lab for analysis.

### Transportation of water samples

Transportation of water samples is made by standard procedures.

## RESULTS AND DISCUSSION

Determining the impact of this pollution is the research orientation of this paper along with an explanation of opportunities for the purification of west water into the river Nerodime. The samplings were performed in January, July, and October 2021.

The presence of suspended particles such as clay, silt, finely split organic materials, plankton, and other tiny creatures causes turbidity in water. Turbidity is a measure of the purity of water. The more suspended particulates there are in the water, the murkier it seems (Sataa et al., 2017). The results show that the mean value of turbidity was 25.01. The minimum turbidity value of S1 sampled in October was 10.92. The maximum turbidity value of S2 sampled in January was 35.80.

The quantity of chlorine that has yet to mix with chlorinated water to properly disinfect pollutants is referred to as free chlorine, which indicates that this chlorine is free to eliminate hazardous bacteria in the water of your swimming pool. This particular sort of chlorine is critical for monitoring purposes. If there isn't enough free chlorine in the water, you won't be able to remove the bacteria and other impurities that have accumulated. Tables 3, 4 and 5 show that the value of free chlorine in all samples is 0.

On a scale of 0–14, the pH of river water indicates how acidic or basic the water is. It is a measure of the concentration of hydrogen ions. Acid rain can increase the acidity of water, but the buffering effect of limestone keeps it under control. pH extremes can render a river unfriendly to life. Immature fish and insects are especially vulnerable to low pH. Acidic water also accelerates the leaching of heavy metals that are hazardous to fish. The pH of the Nerodime River ranges from 6.50 to 7.12, with an average of 6.83 suggesting

**Table 2.** Some surface water quality parameters in Nerodime river

| Parameters | Meaning | Unit | Analytical methods |
|---|---|---|---|
| Turb. | Turbidity | NTU | ISO 7027:2001 |
| Co-Pt | Color | - | ISO 7887:2001 |
| FCl | Free chlorine | mg/l | ISO 7393-1:2000 |
| pH | pH | - | ISO 10523:2008 |
| $NH_4^+$ | Ammonium | mg/l | ISO 7150-5:1984 |
| $NO_2^-$ | Nitrites | mg/l | ISO 7890-3:1988 |
| $NO_3^-$ | Nitrates | mg/l | ISO 7890-2:1988 |
| TP | Total phosphorus | mg/l | ISO 11885:2007 |
| $PO_4^{3-}$ | Phosphate | mg/l | ISO 15681-2:2018 |
| Cond. | Conductivity | µS/cm | ISO 27888:2001 |
| Alk. | Alkalinity | mg/l | ISO 9963-2:1994 |
| $Cl^-$ | Chlorides | mg/l | ISO 9297:2000 |
| $SO_4^{2-}$ | Sulphates | mg/l | ISO 15923-1:2013 |
| Coliform | Total coliform bacteria | MPN/100 ml | ISO 9308-1:2014 |

neutral water. The pH value is within the range permitted by the drinking water standard.

The primary sources of ammonium are sewage treatment plants. The ammonia concentration values in the Nerodime river ranged from 0.039 to 1.976 mg/L. The ammonia concentration should not exceed the ammonia parameter value of 0.2 mg/L. From all of the samples, this high concentration of ammonia was found in samples S5 and S6.

Microbial activity in soil or water converts organic nitrogen wastes to ammonia, which is subsequently oxidized to nitrite and nitrate. Nitrate is the chemical most commonly detected in groundwater and surface waters because nitrite is quickly converted to nitrate. Contamination with nitrogen-containing fertilizers (e.g., potassium nitrate and ammonium nitrate) or organic waste from animals or humans can increase the concentration of nitrate in water. Soil nitrates are often water soluble and rapidly move with groundwater [Mackerness and Keevil 1991; Shuval and Gruener 1992]. The concentrations of nitrites in the Nerodime river ranged from 0.0083 to 0.0794 mg/L, with an average of 0.0331 mg/L. Samples S6 in January among all of the samples contained the highest amount of ammonia. Nitrate concentrations averaged 2.3538 mg/L and varied from 0.725 mg/L at the S5 sample in October to 4.42 mg/L at the S2 sample in January.

To thrive, aquatic environments require nutrients like phosphorus. Different phosphorus ions can be found in water. It can be dispersed, attached to soil and other material particles, or found inside living or decomposing plants and animals. In unpolluted bodies of water, dissolved phosphorus is normally present in low amounts and is readily used by plants and algae. The sum of all of these types of phosphorus is measured as total phosphorus (TP). The Nerodime river's total phosphorus content measurements varied from 0.2525 to 1.1153 mg/L. Total phosphorus concentrations averaged 0.46775 mg/L and varied from 0.2525 mg/L at the S5 sample in October to 1.1153 mg/L at the S6 sample in January. Phosphate concentrations averaged 1.5532 mg/L and varied from 0.9113 mg/L at the S4 sample in October to 3.42 mg/L at the S6 sample in January.

Water can conduct (carry) energy just like metal can. This is a result of dissolved salts in the water. Conductivity will be zero and electricity won't flow through pure water that contains no salts at all. Indirect estimates of the amount of salt in the water are obtained when we test conductivity, which is how quickly electricity can flow through the water. Additionally, the water's temperature affects conductivity. Conductivity rises as the water temperature rises. Additionally, conductivity increases in lakes that do not receive enough rain or stream water.

The lack of rain makes lake water saltier (conductivity) as the lake dries up. In January conductivity values ranged from 299 µS/cm at the S1 to 817 µS/cm at the S6, with an average of 447 µS/cm.

A river's "buffering capacity," or its power to neutralize acids, is gauged by its alkalinity. Baking soda, carbonates, and hydroxides are alkaline substances that dissolve in water to reduce their acidity and remove $H^+$ ions (which means increased pH). They often do this by forming new molecules by interacting with the $H^+$ ions. Without this ability to neutralize acids, adding any acid to a river would immediately modify its pH. It is among the best indicators of how sensitive the river is to acidic inputs. In January alkalinity values ranged from 2.60 mg/L at the S1 to 8.17 mg/L at the S5, with an average of 4.33 mg/L. Between 18.72 mg/L at the S1 sample in October and 78.12 mg/L at the S6 sample in July, sulfate values fluctuated, with an average of 40.32 mg/L.

Due to the risk of obtaining illnesses from bacteria, fecal contamination of water is a severe issue (disease-causing organisms). The variety of potential pathogens is vast, yet pathogen concentrations from fecal contamination are frequently low. As a result, it is impractical to analyze each water sample for pathogens. In contrast, the detection of pathogens is done indirectly by looking for "indicator" organisms like coliform bacteria. The same sources that pathogenic organisms originate from also produce coliforms. Between 30 Cfu/mL at the S1 sample in January to 3640 Cfu/mL at the S2 sample in January, total coliform bacteria on 100 ml values fluctuated, with an average of 1848 Cfu/mL.

In the first sample (S1), by the results of tests we can see that many of the parameters are up to the maximum values in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012), etc. shown in Tables 3–5.

In the second sample (S2), based on the results of the tests, we can see that many of the parameters are up to the maximum values allowed, in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No 30/2014 and Administrative Instruction (MMPH) No 16/2012), etc. shown in Tables 3–5.

In the third sample (S3) by the results of tests, we can see that many of the parameters are up to their maximum values in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012), etc. shown in Tables 3, 4, and 5. By the physic-chemical analysis of the 15th parameter, we can see the influence of wastewater thrown from the citizens of Ferizaj and other villages the impact is very large. The water of River Nerodime due to it's large turbidity, color, and other parameters, because of it's chemical composition, makes it impossible to develop flora and fauna this is confirmed by the research of Bytyqi et al., 2020; Etemi et al., 2020).

In the fourth sample (S4) by the results of tests, we can see that many of the parameters are up to the maximum values in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012), etc. shown in Tables 3–5.

The same was in the samples S5 and S6 by the results of the tests, we can see that many of the parameters are up to the maximum values in

**Table 3.** Results of tests, sampled in January

| Parameter | Unit | Max. range allowed [1] | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|---|
| Turbidity | NTU | < 0.5 | 13.1 | 35.8 | 31.6 | 25.5 | 20.3 | 15.2 |
| Colour | Co-Pt | 10 | 62.4 | 156 | 135 | 142 | 135.36 | 193.8 |
| Free chlorine | mg/l | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| pH | | 6.5-9 | 6.75 | 6.82 | 6.88 | 6.95 | 6.89 | 7.12 |
| Ammonia | mg/l | 10 | 0.039 | 0.078 | 0.075 | 0.9798 | 1.692 | 1.976 |
| Nitrites | mg/l | 0.005 | 0.0091 | 0.021 | 0.018 | 0.041 | 0.059 | 0.079 |
| Nitrates | mg/l | 20 | 2.73 | 4.42 | 4.05 | 2.84 | 0.846 | 1.14 |
| TP | mg/l | 2 | 0.423 | 0.720 | 0.31 | 0.35 | 0.380 | 1.115 |
| $(PO_4)^{3-}$ | mg/l | 1 | 1.274 | 2.1554 | 0.984 | 1.10334 | 1.15902 | 3.42 |
| Conductivity | µS/cm | 600 | 299 | 616.2 | 351 | 417.48 | 647.19 | 817 |
| $P_2O_5$ | mg/l | 2 | 0.97 | 1.66 | 0.72 | 0.81 | 0.86 | 2.54 |
| Alakliniteti | mg/l | > 200 | 2.86 | 4.68 | 3 | 3.266 | 8.178 | 6.27 |
| Chloride | mg/l | 250 | 14.3 | 28.6 | 15 | 14.2 | 14.1 | 24.7 |
| $SO_4$ | mg/l | 400 | 21.71 | 46.28 | 29.85 | 37.204 | 44.133 | 77.71 |
| Total coliform bacteria on 100 ml | Cfu/ml | > 500 | 30 | 3640 | 2100 | 1988 | 1833 | 2660 |

**Table 4.** Results of tests, sampled in July

| Parameter | Unit | Max. range allowed [1] | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|---|
| Turbidity | NTU | < 0.5 | 11.83 | 33.28 | 33.15 | 33.086 | 25.098 | 31.16 |
| Colour | Co-Pt | 10 | 61.1 | 150.8 | 133.5 | 137.74 | 136.77 | 190 |
| Free chlorine | mg/l | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| pH | | 6.5-9 | 6.7 | 6.72 | 6.8 | 6.7 | 6.9 | 6.5 |
| Ammonia | mg/l | 10 | 0.364 | 0.754 | 0.72 | 0.8804 | 1.4241 | 1.938 |
| Nitrites | mg/l | 0.005 | 0.009 | 0.018 | 0.014 | 0.029 | 0.053 | 0.074 |
| Nitrates | mg/l | 20 | 2.704 | 3.417 | 3.015 | 2.627 | 0.8178 | 0.988 |
| TP | mg/l | 2 | 0.40 | 0.57 | 0.29 | 0.28 | 0.28 | 0.94 |
| $(PO_4)^{3-}$ | mg/l | 1 | 1.261 | 2.08 | 1.134 | 1.01 | 1.10 | 3.19 |
| Conductivity | µS/cm | 600 | 303.6 | 318 | 307.2 | 378 | 614.9 | 533.5 |
| $P_2O_5$ | mg/l | 2 | 0.9256 | 1.742 | 0.72 | 0.75 | 0.86 | 2.69 |
| Alakliniteti | mg/l | > 200 | 2.82 | 5.14 | 3.015 | 2.99 | 7.03 | 6.061 |
| Chloride | mg/l | 250 | 10.4 | 26.2 | 13.7 | 13.9 | 13.7 | 23.8 |
| $SO_4$ | mg/l | 400 | 20.28 | 43.94 | 31.155 | 39.547 | 43.005 | 78.128 |
| Total coliform bacteria on 100 ml | Cfu/ml | > 500 | 68.9 | 3120 | 1950 | 1846 | 1692 | 2850 |

**Table 5.** Results of tests, sampled in October

| Parameter | Unit | Max. range allowed [1] | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|---|
| Turbidity | NTU | < 0.5 | 10.92 | 25.6 | 28.7 | 29.8 | 22.25 | 23.78 |
| Colour | Co-Pt | 10 | 56.4 | 116 | 115.7 | 124.16 | 121.25 | 145 |
| Free chlorine | mg/l | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| pH | | 6.5-9 | 6.87 | 6.69 | 6.91 | 6.88 | 6.89 | 7.01 |
| Ammonia | mg/l | 10 | 0.336 | 0.58 | 0.624 | 0.79 | 1.2625 | 1.479 |
| Nitrites | mg/l | 0.005 | 0.0083 | 0.014 | 0.012 | 0.027 | 0.047 | 0.056 |
| Nitrates | mg/l | 20 | 2.49 | 3.81 | 2.61 | 2.36 | 0.72 | 0.75 |
| TP | mg/l | 2 | 0.37 | 0.444 | 0.25 | 0.25 | 0.25 | 0.72 |
| $(PO_4)^{3-}$ | mg/l | 1 | 1.164 | 1.602 | 0.98 | 0.91136 | 0.98 | 2.436 |
| Conductivity | μS/cm | 600 | 303.6 | 318 | 307.2 | 378 | 614.9 | 533.5 |
| $P_2O_5$ | mg/l | 2 | 0.85 | 1.34 | 0.62 | 0.68 | 0.76 | 2.06 |
| Alakliniteti | mg/l | > 200 | 2.60 | 3.96 | 2.613 | 2.70 | 6.23 | 4.62 |
| Chloride | mg/l | 250 | 9.624 | 20.2 | 11.89 | 12.5 | 12.2 | 18.2 |
| $SO_4$ | mg/l | 400 | 18.72 | 33.8 | 27.00 | 35.6 | 38.1 | 59.6 |
| Total coliform bacteria on 100 ml | Cfu/ml | > 500 | 63.6 | 2400 | 1690 | 1664 | 1500 | 2175 |

conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012), etc. shown in Tables 3–5. From the results of the analyses, we can see that many of the parameters are up to the maximum values allowed by the legislation in force in Kosovo (Luzha et al., 2014).

This makes that the waters of river Nerodime in its natural state can't be used for swimming, recreation, and water sports, to raise the low quality of fish and water which then by the common methods of processing (coagulation, sedimentation, filtration, disinfection, etc.) aren't appropriate for public use.

Table 6 and Figure 1 show the correlation between physico-chemical parameters and total coliform bacteria. We have a strong significant relationship $p<0.01$ between turbidity, color, chlorides, joint sulfate and total coliform bacteria, while a significant relationship $p<0.05$ also appears between P, $(PO_4)^{3-}$, $P_2O_5$ and total coliform bacteria. The color represents a strong significant relationship $p<0.01$ with Ammonia, Nitrites, P,

**Table 6.** Pearson correlation between measured water quality variables and Total coliform bacteria

| Specification | Turb | Colour | Free chlorine | pH | Ammonia | Nitrites | Nitrates | P | $(PO_4)^{3-}$ | Conductivity | $P_2O_5$ | Alakliniteti | Chloride | $SO_4$ | Total coliform bacteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turb | 1 | .577* | .b | -.257 | -.037 | -.023 | .355 | -.062 | .006 | -.067 | .034 | -.020 | .402 | .211 | .745** |
| Colour | .577* | 1 | .b | .129 | .652** | .726** | -.228 | .601** | .640** | .635** | .632** | .540* | .692** | .876** | .883** |
| Free chlorine | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b | .b |
| pH | -.257 | .129 | .b | 1 | .211 | .281 | -.273 | .037 | -.018 | .455 | -.084 | .138 | -.136 | .098 | .002 |
| Ammonia | -.037 | .652** | .b | .211 | 1 | .937** | -.842** | .466 | .515* | .714** | .518* | .746** | .204 | .801** | .325 |
| Nitrites | -.023 | .726** | .b | .281 | .937** | 1 | -.778** | .579* | .594** | .851** | .594** | .772** | .321 | .875** | .400 |
| P | -.062 | .601** | .b | .037 | .466 | .579* | -.206 | 1 | .988** | .553* | .969** | .386 | .785** | .830** | .501* |
| $(PO_4)^{3-}$ | .006 | .640** | .b | -.018 | .515* | .594** | -.241 | .988** | 1 | .527* | .991** | .410 | .800** | .860** | .544* |
| Conductivity | -.067 | .635** | .b | .455 | .714** | .851** | -.602** | .553* | .527* | 1 | .498* | .817** | .408 | .744** | .433 |
| $P_2O_5$ | .034 | .632** | .b | -.084 | .518* | .594** | -.252 | .969** | .991** | .498* | 1 | .426 | .807** | .861** | .553* |
| Alakliniteti | -.020 | .540* | .b | .138 | .746** | .772** | -.636** | .386 | .410 | .817** | .426 | 1 | .380 | .635** | .406 |
| Chloride | .402 | .692** | .b | -.136 | .204 | .321 | .183 | .785** | .800** | .408 | .807** | .380 | 1 | .683** | .827** |
| $SO_4$ | .211 | .876** | .b | .098 | .801** | .875** | -.498* | .830** | .860** | .744** | .861** | .635** | .683** | 1 | .671** |
| Total coliform bacteria | .745** | .883** | .b | .002 | .325 | .400 | .136 | .501* | .544* | .433 | .553* | .406 | .827** | .671** | 1 |

**Note:** * correlation is significant at the 0.05 level (2-tailed), ** correlation is significant at the 0.01 level (2-tailed). b – cannot be computed because at least one of the variables is constant.

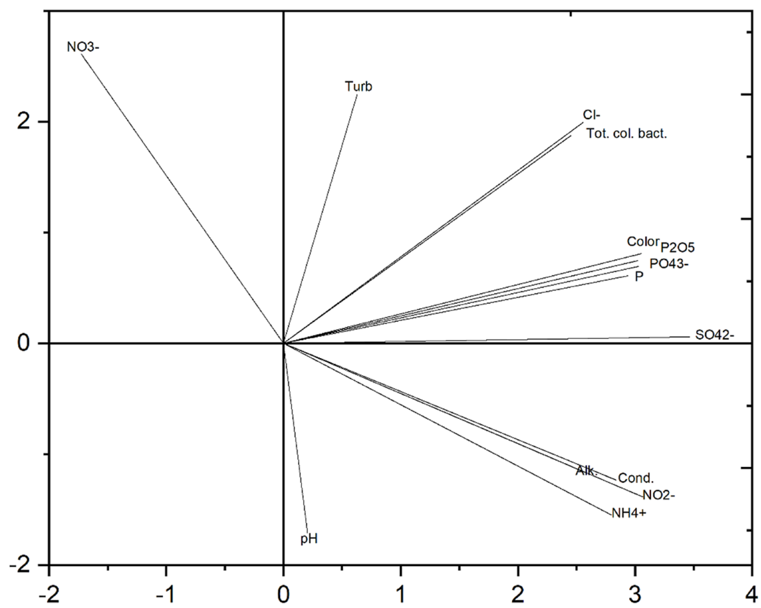


**Figure 1.** CCA (canonical correspondence analysis) plot showing the relationships between physicochemical parameters and total coliform bacteria

$(PO_4)^{3-}$, conductivity, $P_2O_5$, chloride, $SO_4$, as well as a strong significant relationship $p<0.01$ also represents ammonia with nitrites, conductivity, alkalinity and $SO_4$. Nitrites with color, ammonia, $(PO_4)^{3-}$, conductivity, and alkalinity also present a strong significant relationship $p<0.01$. A strong significant negative relationship appears between ammonia, nitrites, conductivity, and alkalinity with nitrates.

## CONCLUSIONS

The surface water quality multiple metrics including fifteen parameters with a total of ninety physic-chemical properties were used to assess the quality of the Nerodime water in Kosovo and as input in multivariate statistical analysis. Water samples were collected three times a year at six locations along the Nerodime River, including S1: position on the connection with wastewater, S2: position after joining with wastewater, S3: Gerlice, S4: Kaçaniku I Vjeter, S5: Stagove and S6: Kaçanik. Standard methods were used to collect and transport the water samples. The samples were taken in January, July, and October of 2021.

Sample S6 had the highest values of the parameters tested for determining water quality among all water samples. According to the data, a high concentration of ammonia was identified in sample S6, with a value of 1.976 mg/L in January, and the concentration of ammonia began to decline throughout the months, reaching 1.479 mg/L in October. The highest concentration of nitrites was identified in sample S6, with a value of 0.079 mg/L in January, and the concentration of ammonia also began to decline also throughout the months, reaching 0.056 mg/L in October. The highest total phosphorus, phosphate, and sulfate concentrations were also identified in sample S6.

Based on the study of all the results, we may infer that human influence has contaminated the Noredime river and many pf the tested parameters are above the maximum values allowed in conformity with the legislation in Kosova (Administrative Instruction (MMPH) No. 30/2014 and Administrative Instruction (MMPH) No. 16/2012). This pollution is most visible in Kaçanik, where the values of the measured parameters are significantly greater than everywhere else. The major cause is that wastewater is discharged in greater volumes in Kaçanik than in other localities.

From all this work, we can conclude that it is urgent and necessary that any type of polluted water without treatment is not thrown into the Nerodime River.

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