Determinaton of Surface Water Quality in the Lumbardh Stream, Prizren, Kosovo: COVID-19 Lockdown Effects on Stream Water Quality

Sami Gashı[1], Cengiz Cesko[1*], Hyrije Koraqı[1]

[1] Food Science and Biotechnology, Agriculture and Environmental Engineering, University of Business and Technology, Pristina, Kosovo

* Corresponding author's e-mail: cengiz.cesko@ubt-uni.net

ABSTRACT

The COVID-19 pandemic has had enormous effects on human life and the environment globally. Despite the negative effects of the epidemic on human health, the pandemic has improved the quality of the environment, thus creating an opportunity to restore degraded ecosystems. This study presents the impact of the COVID-19 pandemic on the water quality and chemical properties of the Lumbardh Stream, which is a very important stream for the city of Prizren, Kosovo. Lumbardh Stream, where industrialization is high in Prizren and industrial wastes are dumped, flows into the White Drin river, which is important for river fishing and agricultural irrigation for both Kosovo and Albania. Therefore, water samples were taken every month in 2020–2021 from the riverbed in the Vlashnje region of Prizren. EC, pH, TDS and Tur were measured *in situ* in the water samples taken. Major ions, heavy metals, DO, BOD, COD, TSS and TOC amounts were analyzed in the laboratory. The results are evaluated according to "Quality criteria according to the classes of intracontinental surface water resources in terms of general chemical and physicochemical parameters"; It has been determined that the water source has Class I in terms of DO, EC and NO_3^--N, Class II in terms of COD, Class III in terms of BOD, total P, PO_4^{3-} and NH_4^+-N. When comparing the pre-lockdown and lockdown period, DO and TOC level increased 1.1 and 1.1 times, BOD, COD and NH_4^+-N decreased 1.2, 1.9 and 1.5 times at lockdown period, respectively. Comparing lockdown and no-lockdown period, DO and TOC increased 1.16 and 3.68 times, BOD, COD and NH_4^+-N decreased 1.1, 3.5 and 1.6 times at lockdown period, respectively. The results obtained showed quality water improvement during the lockdown period. This study confirms that significant recovery of degraded aquatic ecosystems is possible by limiting human activities.

Keywords: surface water; water quality; physical-chemical parameter; heavy metals; Covid 19; Lumbardh stream.

INTRODUCTION

Today, human activities are at the root of environmental problems that have reached a level that threatens the life of living things. One of the important effects of environmental problems on human health is the spread of various diseases. As nature is destroyed and biodiversity decreases, the interaction between humans and wildlife increases, and as a result, the risk of disease transmission from animals to humans increases (Ciotti et al., 2020).

The coronavirus epidemic (COVID-19), which affects the whole world today, is also a zoonotic disease and emerged in the city of Wuhan, China, where people have destroyed nature to such an extent and come into contact with wildlife. Due to the epidemic declared as a pandemic by the World Health Organization (WHO), hundreds of thousands of people were infected in the first six months of 2020 and tens of thousands of them died. Many precautions have been taken by governments around the world to control the COVID-19. Quarantine such as curfew, travel restriction, working from home, social distance, and hygiene such as compulsory use of masks were taken. The primary purpose of these measures is

to secure human health and life; however, some indirect effects of the precautions on the environment were also revealed. As a result of the quarantine, the use of private and public transport and industrial activity in cities has also decreased. In summary, there was a slowdown in human activities, which are the locomotive of environmental pollution, and as a result of the quarantine, a series of positive effects emerged in terms of environmental problems such as reduction of air pollution, water pollution and noise pollution (Sisli, 2020).

The effects of Covid 19 quarantines on air quality worldwide have attracted great attention and many studies have been carried out in this area (Chaudhary et al., 2021; Venter et al. 2020). Conversely, positive environmental impacts of COVID-19 lockdowns have been reported by numerous studies (Braga et al., 2020; Khan et al., 2021; Paital, 2020; Saadat et al., 2020; Yunus et al., 2020). In particular, many studies across the world have suggested that COVID-19 lockdowns improved air quality by reducing nitrogen dioxide (NO_2), carbon dioxide (CO_2), as well as noise (Bar, 2020; Khan et al., 2021; Saadat et al., 2020; Tadano et al., 2021; Tobías et al., 2020). However, studies showing the effects of the covid 19 epidemic on water quality are rare. Recent studies of water quality have revealed that pollution levels in heavily polluted freshwater ecosystems have decreased significantly during the quarantine period (Yunus et. al., 2020). Some studies have reported positive impacts of COVID-19 lockdowns on water quality (Khan et al., 2021; Saadat et al., 2020; Sharifi and Khavarian-Garmsir, 2020). For example, a remarkable improvement in water quality of the Ganges and Mandakini Rivers in India has been determined (Dutta et al., 2020). Other example, reduced discharges of industrial effluent and vessel traffic improved water transparency in Venice Lagoon, Italy (Braga et al., 2020). Yunus et al. (2020) reported that within Lake Vembanad, the longest freshwater lake in India, the concentration of suspended particulate matter decreased by an average of 15.9% during a period of lockdown in April 2020. In addition, a study about river water quality in China, which was the first country to implement a COVID-19 lockdown beginning in Wuhan City, was carried out and results showed that the COVID-19 lockdown led to a general improvement in river water quality in China during the lockdown period of February–May 2020.

COVID-19 pandemic has caused profound impacts on human life and the environment including freshwater ecosystems globally. Despite the various impacts, the pandemic has improved the quality of the environment and thereby creating an opportunity to restore the degraded ecosystems. This study presents the imprints of COVID-19 lockdown on the surface water quality and chemical characteristics of the urban-based Lumbardh River, Prizren, Kosovo. Lumbardh is an important stream for the city of Prizren. This stream flows the White Drime, which is important for both Kosovo and Albania. The Lumbardh stream flows from the Vlashnje region of Prizren to the White Drin river. The increasing in the industrialization of the region and the increasing in constructions are gradually disrupting the water system of the stream. This study was carried out to examine the effect of the Covid 19 pandemic on the water quality of Lumbardh stream between 2020 and 2021 and to determine the water quality of the stream. Water quality is a result of human activities as well as its natural physical and chemical state. Whether the water is used for a specific purpose or not is determined by the water quality. It is said that human activities change the quality of natural water and the water that was suitable for use before is no longer suitable for use and the water is polluted (Gültekin et al., 2012).

Classification made according to the quality of intracontinental surface waters accumulated in rivers, lakes and dam reservoirs; high quality water (Class I), slightly polluted water (Class II), polluted water (Class III) (Anonymous, 2015). The water quality parameters valid for classification and their limit values are given separately for Classes I, II and III as seen in Table 1. For a water source to be included in any of these classes, all parameter values must be in harmony with the parameter values given for that class. Water samples were taken from the Lumbardh Stream in the Vlashnje region of Prizre in certain periods and in order to determine the water pollution of the stream; temperature (T), pH, Turbidity (Tur), Eletrical conductivity (EC), Total dissolved solids (TDS), Dissolved oxygen (DO), Biochemical oxygen demand (BOD), total suspended solids (TSS), total organic carbon (TOC), anion and heavy metal analyzes were measured. This study gave us the opportunity to evaluate the diffrences in water quality of Lumbardh stream between the pre-lockdown, lockdown and no-lockdown periods. It also allowed us to determine whether the water

quality was up to the standard. Therefore, this study provides important information about the fact that limiting polluting industrial activities and anthropological effects to certain periods will give positive results within the scope of improving water quality and that pesticide analysis should be prioritized in Kosovo.

MATERIALS AND METHODS

Study area and sampling

The Lumbardh stream joins with other streams along its path and flows into the White Drin river, which is important for agricultural irrigation and river fishing in Kosovo and Albania (Figure 1). The spillage of wastewater from some factories along the Lumbardh stream and pesticides due to agricultural spraying causes serious pollution in the long term.

In this study, at the same times every month in 2020 and 2021, surface water samples were collected from the Vlashnje region of the Lumbardh stream located in the borders of the province of Prizren. The coordinates of the sampling point were recorded as latitude 42°12`10``N, longitude 20°38`11``E. During the pandemic in Kosovo, quarentine was only applied in April and May 2020.

Therefore, the samples taken before the pandemic restriction was called pre-lockdown, the samples taken in April and May in 2020 was called lockdown and the other samples taken in other months was called no-lockdown period.

In this study, the water quality of the Lumbardh stream in 2020 and 2021 was also evaluated according to the "Quality criteria according to the classes of intracontinental surface water resources in terms of general chemical and physicochemical parameters" standard. The water samples analyzed in the study were collected 10 cm below the water surface and stored at +4 °C in 500 ml polypropylene bottles until analysis.

Water quality measurements

T, pH, EC and Tur were measured *in situ* in the water samples taken. A portable device TUR-BIQUANT Model 1100 T was used for Tur measurement. pH, T, EC and TDS were measured with the portable YSI Multiparameter (YSI Incorporated, 2009) device. Major ions, heavy metals, DO, BOD, COD, TSS and TOC amount in the water samples taken were analyzed in laboratory. In the laboratory, some of the water samples were filtered on the day of sampling. 8 metals (Cr, Mn, Ni, Cu, Zn, Cd, Pb and Fe) in filtered water samples were measured in the laboratory with Perkin Elmer AA30 model atomic absorption spectroscopy. 6 ions (NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, Total Phosphorus, SO_4^{2-}) were measured by Shimadzu, CTO-20 AC SP (Ion-Chromatograph). DO was made by the Winkler method (Carpenter, 1965) and the SCHOTT Titroline easy M2 titrator was used for titration. TOC analysis was performed with the GE Sievers 900 TOC analyzer. The determination of BOD, COD and TSS were measured with Secomam pastel UV.
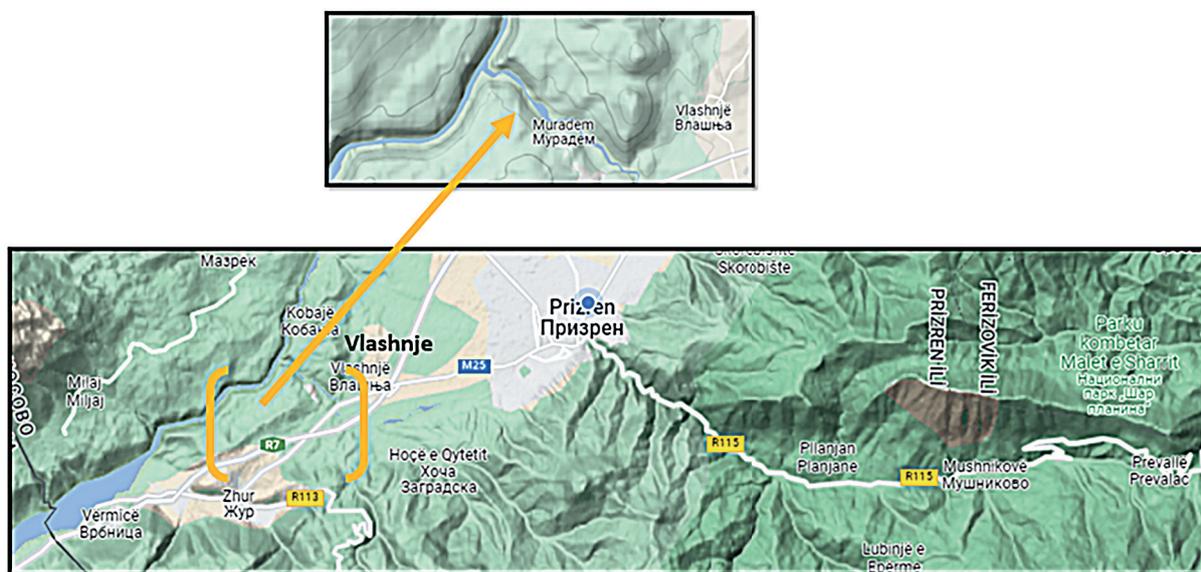
Figure 1. Map showing the monitoring stations in the Lumbardh stream and Vlashnje region

RESULTS AND DISCUSSIONS

Comparison of measurement results with surface water quality standards

In this study, the conformity of the water samples taken from the Lumbardh stream to the "Quality criteria of Intracontinental Surface water resources according to their classes in terms of general chemical and physicochemical parameters" was examined. These criteria are given in Table 1.

The minimum, maximum and average values of the parameters measured in the water samples taken from the Vlashnje region of the Lumbardh stream between 2020–2021 are given in Table 2. Values and changes of major water pollutants by month in 2020–2021 are shown at Figure 2.

In river ecosystems, the water temperature varies depending on the flow rate, volume, depth of the water, the geological and chemical structure of the river bottom and the air temperature (Wetzel, 2001). The water temperature in the study area showed a distribution suitable for seasonal changes. The lowest water temperature was measured as 8 °C in November 2020, while the highest temperature was measured as 20.1 °C in August 2021. The average of the temperature values measured during the two years was determined as 13.4±0.4 °C.

pH value is an important factor for chemical and biological systems in water (Atay and Platsü 2000). It is known that especially fish grow well in waters with suitable pH range (Arrigon, 1976; Dauba, 1981). During the study, the lowest pH value was determined as April 2020 (pH: 7.6), and the average pH range measured between 2020–2021 was determined as 7.70±0.02 (Table 2). When the intracontinental water quality standards (Table 1) specified in the legislation are examined, the high quality water limits given for

the pH parameter are waters between 6–9. In our study, it is seen that the average pH value of the stream has a slightly basic water character and complies with the quality standards.

Conductivity measurement in water is a parameter by which the amount of dissolved substance in water can be monitored. This depends on the total concentration of the ionized substance and the temperature. The increase in conductivity in drinking water is an indication that sea water is mixed with the water or that the water is polluted (Anonymous, 2011). In our study, the EC values changed in direct proportion to the temperature of the water. The lowest conductivity value was measured as 235 in April 2020, while the highest conductivity was measured as 374.9 in October 2021. The mean of conductivity measurements obtained during the study was determined as 324.95±0.32 (Table 2). The values obtained are in compliance with the Class I water resource values according to the Water Pollution Control Regulation Intracontinental Water Resources Criteria.

DO amount, which is vital for aquatic organisms, is expected to be higher than 6 mg/L as per quality standards (Table 1). If the DO concentration drops below 5 mg/L in surface waters, it negatively affects aquatic organisms (Dişli et al., 2004). While the DO value in the monitored water was the lowest in August 2020 (7.39 mg O_2/L), it reached the highest value in May 2020 (11.27 mg O_2/L). The mean DO value between 2020–2021 was determined as 9.81±2.5 mg O_2/L. The amount of DO increased by 10.29% in 2021 (Table 2). When evaluated according to the surface water control regulation, it is compatible with Class I water source values.

BOD can be defined as the amount of oxygen required for organic matter to be broken down

Table 1. Quality criteria of Intracontinental Surface water resources according to their classes in terms of general chemical and physicochemical parameters (Ref.: Anonymous, 2015)

Water quality parameter	Water quality class		
	Class I (very good)	Class II (good)	Class III (medium)
pH	6–9	6–9	6–9
Turbidity (µS/cm)	<400	1000	>1000
DO (mg O_2/L)	>8	6	<6
COD (mg/L)	<25	50	>50
BOD (mg/L)	<4	8	>8
NH_4^+-N (mg/L)	<0.2	1	>1
NO_3^--N (mg/L)	<3	10	>10
PO_4^{3-}(mg/L)	<0.05	0.16	>0.16
Total P (mg P/L)	<0.08	0.2	>0.2

and digested by bacteria under aerobic conditions (Kaplan and Sönmez, 2000). A small BOD value indicates that the water is clean or that microorganisms do not consume the organic matter in the water (Turan and Ülkü, 2013). BOD in Lumbardh stream was measured as 9.92 mg/L in January 2020. This value is the highest measured value. The lowest value measured was 6.18 mg/L in December 2020. Between the years 2020–2021, the mean BOD was measured as 8.16±1.1 mg/L. In 2021, this value increased by 5.28% (Table 2). This value is showed that it is between Class III quality water limits according to the surface water control regulation.

COD is based on the oxidation of organic substances in water with strong oxidizing chemicals at high temperature in an acidic environment. During the test, organic substances with carbon turn into CO_2 and water, and nitrogenous organic substances into ammonia. It is the most important test parameter used to determine the degree of pollution in water and wastewater samples (Said et al., 2021). As a result of the COD determination of a water, the COD is always obtained greater than the BOD, since it also contains some substances that do not decompose by biological means. However, if the water source is exposed to high levels of pollution, the BOD value may

be higher than the COD value. The COD value of the measured water was measured as 1 mg/L in May 2020, and this value shows that the pollution in the water was minimal at this period. In October 2020, the COD value was measured as 194 mg/L. This value is the maximum value measured between 2020–2021. The average COD value between 2020–2021 was determined as 25.74±3.4 mg/L. When this value is compared with the quality criteria given in Table 1, Class II complies with water criteria. The COD value of the stream decreased by 34.40% in 2021 (Table 2).

The turbidity of the water is directly related to the amount of suspended solids in the water, the depth of the water, the season and environmental conditions. TSS in water usually causes physical contamination of water after a certain amount. Therefore, it can increase the turbidity, condensation and toxicity of the water, as well as reduce the light transmittance and the amount of oxygen, and damage the aquatic life by precipitating on the fauna and flora. The turbidity of the Lumbardh stream was lowest in August 2020 (9.4 NTU), while it was highest in October 2020 (115 NTU). The average turbidity value between 2020–2021 was determined as 35±0.2 NTU. It was determined that the turbidity values of the Prizren stream were higher in the seasons with
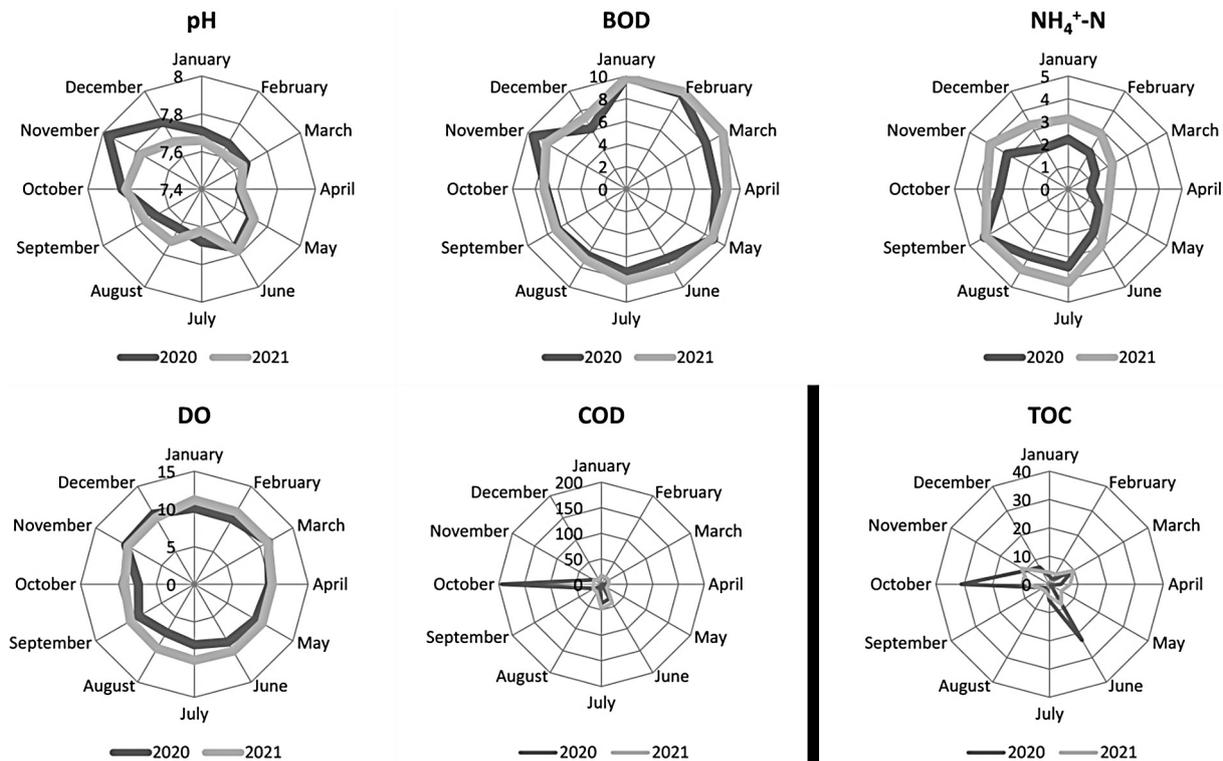

Figure 2. Values of major water pollutants by month in 2020–2021

Table 2. Mean, minimum and maximum values of water quality variables determined in 2020 and 2021

Variable	Unit	2020			2021				
		Min.	Max.	Mean*	Min.	Max.	Mean*	Difference	dif.(%)
pH	-	7.6	7.97	7.72	7.62	7.8	7.69	-0,03	-0.39
T	∘C	8	18.5	13.1	9.2	20.1	13.8	0.7	5.34
EC	µS/cm	235	396	322	284.5	374.9	327.9	5.9	1.83
Tur	NTU	9.4	115	35	12.52	58.43	35.22	0.22	0.63
TDS	mg/L	132.6	183.3	160.97	128.6	199.4	154.25	-6.72	-4.17
DO	mg O_2/L	7.39	11.27	9.33	9.22	11.2	10.29	0.96	10.29
BOD	mg/L	6.18	9.92	7.95	7.16	9.27	8.37	0.42	5.28
TSS	mg/L	0	158	26.6	2.99	15.63	8.50	-18.1	-68.05
COD	mg/L	1	194	31.08	11.2	47	20.39	-10.69	-34.40
TOC	mg/L	0.5	22.8	7.70	2.9	25,4	7.86	0.86	2.07
NO_3^--N	mg/L	0.8	3.7	2.035	1.95	3.01	2.38	0.345	16.95
NO_2^-	mg/L	0.1	0.49	0.24	0.095	0.459	0.261	0.021	8.75
NH_4^+-N	mg/L	0.99	4.25	2.46	1.82	4.19	3.18	0.72	29.27
$PO4_3^-$	mg/L	0.37	1.83	1.29	0.75	1.96	1.32	0.03	2.33
Total P	mg P/L	0.27	0.795	0.494	0.222	0.711	0.477	-0.017	-3.44
SO_4^{2-}	mg/L	6.219	20.87	11.679	9.53	16.23	13.27	1.591	13.62
Cr	µg/L	0.198	0.209	0.204	0.2	0.211	0.209	0.005	2.45
Mn	µg/L	0.076	0.192	0.134	0.082	0.19	0.136	0.002	1.49
Ni	µg/L	0.025	0.032	0.029	0.019	0.035	0.030	0.001	3.44
Cu	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-
Zn	µg/L	0.006	0.009	0.008	0.005	0.010	0.008	-	-
Cd	µg/L	0.011	0.011	0.011	0.010	0.011	0.011	-	-
Pb	µg/L	0.008	0.011	0.010	0.010	0.013	0.011	0.001	10
Fe	µg/L	0.054	0.211	0.133	0.069	0.266	0.165	0.032	24.06

Note: * the average of the values measured every month.

the highest rainfall during the study according to the seasons. The high rainfall in the spring and autumn seasons caused the turbidity values to be high. TSS was determined as 17.55±1.2 on average between 2020–2021, and the highest TSS value was 158 mg/L in October 2020, and the lowest TSS value was 0 mg/L in February 2020.

TDS is used to express mineral, metal, salt and similar substances that are dissolved in water and cannot be seen with the naked eye. When the TDS value of the Lumbardh stream was measured, the lowest value was 128.6 mg/L in February 2021, and the highest value was 199.4 mg/L in August 2021. Since the temperature will affect the amount of water, an increase in the measured substance concentrations in the water is an expected situation. In addition, it is seen that conductivity and TDS values decrease due to the high turbidity values due to the effect of precipitation in the spring and autumn seasons. The fact that both TDS and EC values are high in summer is due to the presence of more dissolved ions in the

water. The mean amount of TDS between 2020–2021 was determined as 157±6.1 mg/L. This value decreased by 4.17% in 2021 (Table 2).

TOC a measure of the total amount of carbon in organic compounds in pure water and aqueous systems. These organic substances in water can come from different sources; industry, agricultural spraying, etc. The lowest TOC value in the measured water was obtained in May 2020 (0.5 mg/L). In June 2021, the TOC value was measured as 25.4 mg/L. This value is the maximum measured value. When Table 2 are examined, it is seen that the TOC values of 2021 have increased compared to 2020 (2.07%). It is thougt that this is due to the fact that the local people are engaged in agriculture along the Lumbardh Stream. Since pesticides used in agriculture are organic compounds, it is thought that they cause high TOC values. It is thought that this value increases due to the pesticides being transferred to the water with the rains after spraying. We think that some precautions should be taken, especially in terms of pesticide

use, as the increase in TOC value in the coming years may lead to deterioration of the ecological balance and environmental pollution.

Nitrogen compounds; have significant effects on water pollution. The natural nitrogen in the water is due to the microorganisms in the water and precipitation. Waste water treatment systems, animal waste, beer and dairy industry are important nitrogen sources (Atay and Pulatsü, 2000; Ozdemir et al. 2004). The ammonium ion is not significantly toxic to aquatic organisms. However, depending on the high pH and temperature, ammonium can turn into ammonia and become toxic to fish and other creatures in the aquatic environment (Ünlü et al. 2008; Birici, 2017) The minimum amount of NH_4^+-N in the measured water was 0.99 mg/L in May 2020, and the maximum amount of NH_4^+-N was 4.25 mg/L in September 2020. The mean amount of NH_4^+-N between 2020–2021 was determined as 2.82±0.95 mg/L. It is observed that this value increased by 29.27% in 2021 compared to 2020 (Table 2). When this value is evaluated with the quality criteria given in Table 1, the water measured is Class III. It appears to be within the quality criteria.

NO_3^--N concentration in Lumbardh stream was determined as 0.8 mg/L in October 2020. While this was the lowest value measured, the highest value was measured as 3.01 mg/L in May 2021. The mean NO_3^--N concentration measured between 2020–2021 was determined as 2.20±0.45 mg/L. It is observed that this value increased by 16.95% in 2021 (Table 2). This value shows that the water is Class I in terms of Water Pollution Control Regulation Criteria (Table 1). When the NO_2^- concentration of the stream was measured, the minimum value was obtained as 0.1 mg/L in March 2020, and the maximum value was obtained as 0.49 mg/L in July 2020. The mean NO_2^- concentration between 2020–2021 was determined as 0.25±0.1 mg/L. When Table 2 is examined, it is seen that the NO_2^- concentration increased by 8.75% in 2021.

When the PO_4^{3-} amount of the stream was examined, the lowest and highest values were measured as 0.37 mg/L (March 2020) and 1.96 mg/L (October 2021) respectively. The mean value between the specified years was determined as 1.30±0.79 mg/L. When this value is evaluated according to the quality criteria given in Table 1, It shows that it is a Class III quality water. When the total P (mg P/L) value of the stream was measured, the minimum value was measured as 0.222 mg P/L in March 2021, and the maximum value was measured as 0.795 mg P/L in May 2021. The mean value between 2020–2021 was determined as 0.48±0.1 mg P/L. The total P value of the stream decreased by 3.44% in 2021 (Table 2). When this value is compared with the quality criterion value given in Table 1, It is seen that it is in Class III quality water criteria.

When the SO_4^{2-} concentration of Lumbardh stream was examined, the lowest value was 6.219 mg/L (June 2020) and the highest value was 20.87 mg/L (November 2020). Between 2020–2021, this value was determined as 12.47±1.4 mg/L on average. This value increased by 13.62% in 2021.

When the water samples taken from the selected Vlashnje location of the Lumbardhi stream are examined, it is seen that there is not much change in the heavy metal ion concentrations of the water in 2020 and 2021 (Table 2). When the results in Table 2 are examined, it is seen that while Cu in the water of Lumbardh stream remains below the analysis limit, there is little change in all other metals. The metal that accumulated the most in the water was Fe, Pb and Mn, and the metal that accumulated the least was Zn. While the amount of Fe in water was in the range of 0.054–0.211 mg/L in 2020, it is seen to be in the range of 0.069–0.266 mg/L in 2021. While the amount of Mn in water was in the range of 0.076–0.192 mg/L in 2020, it was measured between 0.082 – 0.190 mg/L in 2021. The amount of Pb in water is in the range of 0.008–0.012 mg/L in 2020, and in the range of 0.011–0.013 mg/L in 2021. It is seen that there is not much change in the metal concentrations of Cd, Cr and Ni in the water. According to the standards set by the Environmental Protection Agency (EPA 2002) and the World Health Organization (WHO), metal concentrations in the Lumbardh stream are below the detection limit. When the data in Table 2 is examined, it is seen that the concentrations of some heavy metals increased in 2021. It is predicted that this increase will have a negative impact on the biological balance in the long term or in the coming years, if it exceeds the standards set by the World Health Organization. Therefore, it is inevitable to take some precautions in order not to face this danger in the coming years.

COVID-19 lockdown improved river water quality in the Lumbardh River

The Covid 19 is an epidemic that has affected the world. Countries have had to apply restrictions

to minimize the effects of this epidemic. The first Covid case in Kosovo was determined on March 13, 2020. In order to prevent the spread of the Covid epidemic in Kosovo, certain restrictions began to be implemented in the country on March 24, 2020. While the restrictions were at the highest level in April-May of 2020, restrictions were reduced as in the whole World, with the arrival of the summer months in the following dates. In this study, the collection of water samples from the Lumbardh stream started in January 2020, when the covid epidemic and restrictions had not yet started in Kosovo. For this reason, in this study, the water quality of the Lumbardh stream was examined according to the standard "Quality criteria of intracontinental surface water resources according to their classes in terms of general chemical and physicochemical parameters", as well as the effect of the decrease in anthropological activities caused by the Covid restrictions on the water quality of the stream. For this purpose, January,

February and March, when there are no restrictions and covid cases, was determined as pre-lockdown, April-May as lockdown, and all other months without restrictions as no-lockdown period, and the data are given in Table 3 and Figure 3.

When the results are examined, Lumbardh stream was determined to be neutral to slightly alkaline water with relatively moderate mineralization and dissolved chemical components.. Average ionic abundance during-lockdown is $NH_4^+>Cr^{3+}>Mn^{2+}>Fe^{2+}>Ni^{2+}>Cd^{2+}>Pb^{2+}>Zn^{2+}>Cu^{2+}$ for metals and It followed the order $SO_4^{2-}> NO_3^->PO_4^{3-}>P>NO_2^-$ for anions When comparing the pre-lockdown and lockdown period, DO and TOC level increased 1.1 and 1.1 times, BOD, COD and NH_4^+-N decreased 1.2, 1.9 and 1.5 times at lockdown period, respectively. Comparing lockdown and no-lockdown period, DO and TOC increased 1.16 and 3.68 times, BOD, COD and NH_4^+-N decreased 1.1, 3.5 and 1.6 times at lockdown period, respectively. The results obtained showed quality

Table 3. Mean, minimum and maximum values of water quality variables determined in the pre-lockdown, during-lockdown and no-lockdown periods

Variable	Unit	Pre-lockdown			Lockdown			No-lockdown		
		Min.	Max.	Mean*	Min.	Max.	Mean*	Min.	Max.	Mean*
pH	-	7.67	7.71	7.68	7.6	7.7	7.65	7.62	7.97	7.71
T	°C	10.2	10.6	10.4	11.2	15.9	13.55	10.2	18.5	13
EC	µS/cm	292	316	0.311	235	244	239.5	292	396	340
Tur	NTU	11.3	22.4	19.27	18	98	58	9.4	115	29
TDS	mg/L	148	159	153	120	123	121.5	148	199	171
DO	mg O$_2$/L	9.36	9.91	9.63	10.02	11.27	10.46	7.39	11.27	9.83
BOD	mg/L	8.1	9.92	9.26	7.2	7.9	7.55	6.18	9.97	8.15
TSS	mg/L	2.1	42	16.3	2.4	5.51	3.955	2.1	158	31.6
COD	mg/L	14	16.2	15.14	1	15	8	10.7	194	27.46
TOC	mg/L	2.1	2.8	2.5	0.5	4	2.25	1.9	25.4	8.29
NO$_3$-N	mg/L	2.65	2.77	2.71	0.99	1.572	1.281	0.8	3.7	2.12
NO$_2^-$	mg/L	0.1	0.18	0.14	0.136	0.245	0.190	0.092	0.424	0.273
NH$_4^+$-N	mg/L	1.38	2.21	1.82	0.99	1.38	1.185	1.82	4.25	2.96
PO4$_3^-$	mg/L	0.37	1.445	0.79	0.618	1.073	0.845	0.37	1.559	1.389
Total P	mg P/L	0.27	0.44	0.34	0.188	0.366	0.277	0.27	0.795	0.542
SO$_4^{2-}$	mg/L	12.43	14.73	13.39	8.939	10.11	9.52	6.22	20.87	12.157
Cr	µg/L	0.200	0.201	0.200	0.198	0.200	0.199	0.198	0.201	0.199
Mn	µg/L	0.095	0.192	0.143	0.076	0.187	0.132	0.092	0.198	0.178
Ni	µg/L	0.030	0.032	0.031	0.025	0.029	0.027	0.030	0.032	0.032
Cu	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	µg/L	0.006	0.009	0.008	0.006	0.009	0.008	0.006	0.009	0.008
Cd	µg/L	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Pb	µg/L	0.009	0.009	0.009	0.008	0.008	0.008	0.007	0.009	0.009
Fe	µg/L	0.054	0.211	0.150	0.062	0.187	0.125	0.051	0.201	0.172

**Note:** * the average of the values measured every month
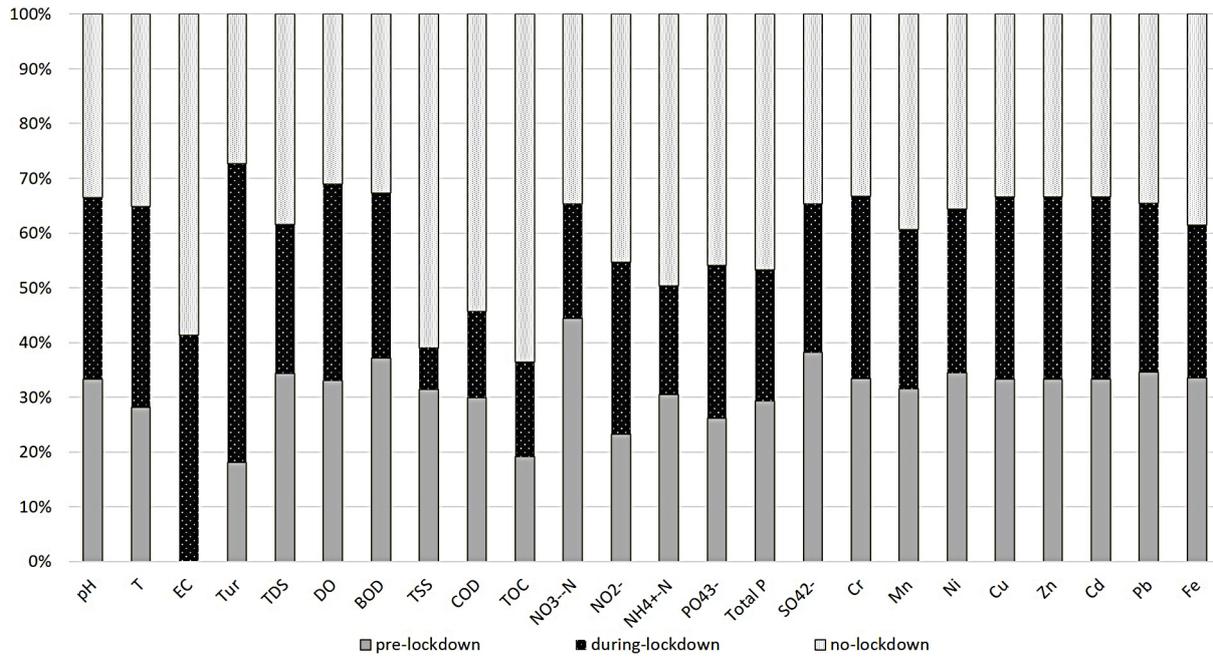
Figure 3. Proportions of different water quality levels between pre-lockdown, lockdown and no-lockdown, in 2020 and 2021

water improvement during the lockdown period. This study confirms that significant recovery of degraded aquatic ecosystems is possible by limiting human activities. However, the amount of TOC increases gradually in 2020 and 2021. It is thought that the TOC value is also related to pesticides and that this value is high will contribute to the understanding of the importance of pesticide analysis in the country.

CONCLUSIONS

When the results obtained in this study and the water quality of the Lumbardh stream are evaluated according to the "Quality criteria according to the classes of intracontinental surface water resources in terms of general chemical and physicochemical parameters"; it is found that the water has Class I quality in terms of DO, EC and NO_3^--N parameters of the water source; Class II quality in terms of COD; Class III quality in terms of BOD, Total P, PO_4^{3-} and NH_4^+-N. It is thought that the increase in the TOC value and the amount of heavy metals will cause serious pollution in the future, and it is seen that it is important to introduce some regulations especially in terms of pesticide use. However, the prevention of direct discharge of wastewater to the receiving environment is one of the leading measures to prevent further deterioration of the

quality of the water source. It is clear that there has been an improvement in water quality, especially due to the decrease in anthropological activities during the Covid restrictions applied for a very short time. It is also thought that the local people should be informed and encouraged to improve the water quality.

REFERENCES

1. Anonim. 2015. Yerüstü Su Kalitesi Yönetmeliği, Resmi Gazete 29327, T.C. Başbakanlık, Ankara. https://www.resmigazete.gov.tr/eskiler/2016/08/20160810-9.htm

2. Arrignon, J. 1976. Aménagement ecologique et piscicole des eaux douces. Bordas, 32, Paris.

3. Atay, D., Pulatsü, S. 2000, Su Kirlenmesi ve Kontrolü. Ankara Üniversitesi Ziraat Fakültesi, Yayın No: 1513, Ankara. https://dspace.ankara.edu.tr/xmlui/handle/20.500.12575/17483

4. Bar, H. 2020. Dev. Sustain., COVID-19 lockdown: animal life, ecosystem and atmospheric environment Environ., 23, 1–18. https://doi.org/10.1007/s10668-020-01002-7

5. Birici, N., Karakaya, G., Şeker, T., Küçükyılmaz, M., Balcı, M., Özbey, N., Güneş, M., 2017. Int. J. Pure Appl. Sci., Çoruh Nehri (Bayburt) Su Kalitesinin Su Kirliliği Kontrolü Yönetmeliğine Göre Değerlendirilmesi, 3(1), 54–64.

6. Braga, F., Scarpa, G.M., Brando, V.E., Manfe, G., Zaggia, L. 2020. Sci. Total Environ., COVID-19 lockdown measures reveal human impact on water

transparency in the Venice lagoon, 736, 139612. https://doi.org/10.1016/j.scitotenv.2020.139612

7. Carpenter, J.H. 1965. Limnology and Oceanography, The Accuracy of the Winkler Method For Dissolved Oxygen Analysis, 135–140. https://doi.org/10.4319/lo.1965.10.1.0135

8. Chaudhary, S., Kumar, S., Antil, R., Yadav, S. 2021. Air Quality Before and After COVID-19 Lockdown Phases Around New Delhi, India, J Health Pollut., 11(30), 210602. https://doi.org/10.5696/2156-9614-11.30.210602

9. Ciotti, M., Ciccozzi, M., Terrinoni, A., Jiang, W.C., Wang, C.B., Bernardihi, S. 2020. Critical reviews in clinical laboratory sciences, special issue: Covid-19 pandemic and the critical role of clinical laboratory. Invited Review Articles, The COVID-19 pandemic, 57, 365–388. https://doi.org/10.1080/10408363.2020.1783198

10. Dauba, F. 1981. Etude comperative de la fauna des poissons dans les ecosystemes de deux reservoirs, Luzech (Lut) et Chastang (Dordogone): These de troisieme cycle L'Institut National Polytechnique de Toulouse, 179.

11. Dişli, M., Akkurt, F., Alicilar, A. 2004. Journal of Gazi University Faculty of Engineering and Architecture. Şanlıurfa Balıklıgöl, Evaluation of Some Chemical Parameters of Water According to Seasons, 19(3), 287–294.

12. Dutta, V., Dubey, D., Kumar, S. 2020. Sci. Total Environ., Cleaning the River Ganga: impact of lockdown on water quality and future implications on river rejuvenation strategies, 743, 140756. https://doi.org/10.1016/j.scitotenv.2020.140756

13. Gültekin, F., Ersoy, A.F., Hatipoğlu, Celep, S. 2012. Ekoloji, Trabzon İli Akarsularının Yağışlı Dönem Su Kalitesi Parametrelerinin Belirlenmesi, 21(82), 77–88. https://doi.org/10.5053/ekoloji.2011.8211

14. Kaplan, M., Sönmez, S., 2000. Ekoloji Çevre Dergisi, Belek Özel Çevre Koruma Alanı Akarsularının Su Kalitelerinin ve Kirleticilerinin Değerlendirilmesi, 9(34), 21–26.

15. Khan, I., Shah, D., Shah, S.S. 2021. Int. J. Environ. Sci. Technol., COVID-19 pandemic and its positive impacts on environment: an updated review, 18, 521–530. https://doi.org/10.1007/s13762-020-03021-3

16. Özdemir, M., Yavuz, H., İnce, S. 2004. Ankara Üniversitesi Veterinerlik Fakültesi Dergisi, Afyon Bölgesi Kuyu Sularında Nitrat ve Nitrit Düzeylerinin Belirlenmesi, 51, 25–28. https://doi.org/10.1501/Vetfak_0000002265

17. Paital, B. 2020. Sci. Total Environ., Nurture to nature via COVID-19, a self-regenerating environmental strategy of environment in global context, 729, 139088. https://doi.org/10.1016/j.scitotenv.2020.139088

18. Saadat, S., Rawtani, D., Hussain, C.M. 2020, Science of the Total Environment, Environmental Perspective of COVID-19. 138870. https://doi.org/10.1016/j.scitotenv.2020.138870

19. Said, N.S.M., Kurniawan, S.B., Abdullah, S.R.S., Hasan, H.A., Othman, A.R., Ismail, N.I. 2021. Science of The Total Environment, Competence of Leptironia articulata in eradicating chemical oxygen demand and ammoniacal nitrogen in coffee processing mill effluent and its potential as green straw, 799, 10. https://doi.org/10.1016/j.scitotenv.2021.149315

20. Sharifi, A., Khavarian-Garmsir, A.R. 2020. Sci. Total Environ., The COVID-19 pandemic: impacts on cities and major lessons for urban planning, design, and management, 749. https://doi.org/10.1016/j.scitotenv.2020.142391

21. Sisli, M. 2020. Covid-19 Pandemisinin Çevre Üzerindeki Etkileri Özel Raporu, yayın no: 007, Rapor no:001 https://webdosya.csb.gov.tr/db/ced/icerikler/2017-cevre-sorunlari-ve-oncel-kler--20190628084520.pdf

22. Tadano, Y.S., Vermaak, S.P., Kachba, Y.R., Chiroli, D.M.G, Casacio, L., Santos-Silva, J.C., Moreira, C.A.B., Machado, V., Alves, T.A., Siqueira, H., Godoi, R.H.M. 2021. Environ. Pollut., Dynamic model to predict the association between air quality, COVID-19 cases, and level of lockdown, 268. https://doi.org/10.1016/j.envpol.2020.115920

23. Tobías, A., Carnerero, C., Reche, C.J.M., Via, M., Minguillón, M.C., Alastuey, A., Querol, X. 2020. Sci. Total Environ., Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic, 726, 138540. https://doi.org/10.1016/j.scitotenv.2020.138540

24. Turan, F., Ülkü, G. 2013. Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi, Monitoring Water Quality Parameters And Pollution Discharge Loads Of Gökpınar And Çürüksu Creeks, Denizli, Turkey, 19(3), 133–144. https://doi.org/10.5505/pajes.2013.25633

25. Ünlü, A., Çoban, F., Tunç, M.S. 2008. Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi, Hazar Gölü su kalitesinin fiziksel ve inorganik kimyasal parametreler açısından incelenmesi, 23(1), 119–127.

26. Venter, Z.S., Aunan, K., Chowdhury, S., Lelieveld, J. 2020. Earth, Atmospherıc And Planetary Scıences, COVID-19 lockdowns cause global air pollution declines, 117(32), 18984–18990. https://doi.org/10.1073/pnas.2006853117

27. Wetzel, G.R., Likens, G.E. 2000. Limnological analyses. Third Edition. https://books.google.com/books/about/Limnological_Analyses.html?id=XzjC8nNoSmQC

28. Yunus, A.P., Masago, Y., Hijioka, Y. 2020. Sci. Total Environ., COVID-19 and surface water quality: improved lake water quality during the lockdown, 731, 139012. https://doi.org/10.1016/j.scitotenv.2020.139012