Asian Journal of Chemistry; Vol. 33, No. 4 (2021), 925-929

ASIAN JOURNAL OF CHEMISTRY

https://doi.org/10.14233/ajchem.2021.23104

# Seasonal Assessment of Physico-Chemical Parameters and Water Quality Evaluation of Kune-Vaini Lagoon Complex, Lezha, Albania

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*Received*: 20 December 2020; *Accepted*: 20 February 2021; *Published online*: 20 March 2021; AJC-20305

The evaluation of the water quality of the Kune-Vain lagoon complex with regard to general physico-chemical and chemical parameters was the main focus of the present study. This evaluation was based on the requirement of Council Directive of 18 July 1978 on the "quality of fresh waters needing protection or improvement in order to support fish life", [78/659/EEC] and the requirement of Council Directive of 3 November 1998 relating to the "quality of water intended for human consumption", [98/83/EC]. Five sampling stations were selected to successfully perform the water monitoring on the Kune-Vaini lagoon complex with a frequency of every two months, from July, 2018-July, 2019. The parameters measured were temperature, pH, conductivity, salinity, DO, BOD, TDS, total hardness, $Ca^{2+}$, $Mg^{2+}$, $Cl^-$ and some heavy metals. The monitored lagoons have shown notable differences based on physico-chemical parameters.

**Keywords: Lagoon, Physico-chemical parameters, Major ions, Heavy metals.**

## INTRODUCTION

Coastal lagoons are the shallow water bodies separated from the sea by a barrier, connected to the sea by one or more restricted inlets and usually oriented parallel to the shore. The formation of the barrier is crucial, as it allows lagoon waters to acquire significantly different characteristics compared to the nearby seawater [1]. Coastal lagoons occur along 13% of the coastlines of all continents [2]. The quantity and quality of water in the lagoon depends on the degree to which the lagoon loses or gains water from evaporation, precipitation, groundwater inflow and exchange with the sea. Due to the high population density around the Mediterranean coastal areas, lagoons are usually affected by urban activity, agriculture, tourism, mining and other activities related to the lagoons, which become host to various pollutants [1]. These impacts are also reflected in the organisms living in the lagoons, which may be largely different from those of the nearby marine environment. Coastal lagoons are highly productive eco-systems and exhibit numerous economic and environmental values. They house a large variety of habitats [3]. The values of lagoon ecosystems depend according to their geographical position, flora and fauna, visual, historical and archaeological qualities, productivity, possibility of water supply and food for the local community, possibility of flood control, especially in high risk areas, such as and the opportunity for tourisms development [4].

The Lezha lagoon complex comprises more than 30 km of wetlands, extending from Shengjini town in the northern part to the Mati delta in the south. The system covers the Kune-Vaini wetlands on both sides of the Drini delta and the Tale wetlands in the northern part of the Mati delta. The wetland complex extends over an area of more than 30 $km^2$ of which 11 $km^2$ are covered with water, the remains are swamps, reed beds, forests and shrubs as well as cultivable land [4]. The most important lagoon areas are Ceka (4.9 $km^2$) and Zaje (2.4 $km^2$) as part of the Vain complex, south of the Drini delta and Merxhani (2.5 $km^2$) as part of the Kune area north of the Drini delta. Kune-Vaini was the first protected area in the history of nature protection in Albania and categorized in 1960 as Hunting Reserve by the Albanian Government [5]. From years, Kune Vain Tale Protected Area suffers from several issues created by human unplanned activities and climate change effects such as increase of the erosion intensity in coats/littorals and riparian forests and floods on inland agricultural areas; reduction of the lagoon depth by intensive sedimentation coming from eroded site and overflows, block of communication channels

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between sea and lagoons, *etc*. This phenomenon decreased directly the lagoon capability for fish and indirectly made the lagoons very prone to eutrofication, by reduction of vertical and horizontal water circulation capabilities. Threatening of lagoon existence by destroying littorals and creation of one body lagoon/sea waters and the overflows are incited the distribution of contamination in clean sites by transporting the pollution by water running in overflows [4]. The present study is part of a Research Program focused on the ecological approach of the Kune-Vain lagoon complex (Lezha), within the project Construction and sustainability of the Kune-Vain lagoon system through access to the ecosystem (EbA), supported by UNEP, GEF and the Albanian Government.

## EXPERIMENTAL

**Study area and sampling sites:** Five sampling stations were selected to perform the water monitoring on the Kune-Vaini lagoon complex with a frequency of every two months, from July, 2018 to July, 2019. Ceka and Zaje stations were the main focus of this monitoring as they are expected to be directly impacted due to the opening of the new tidal channel which will help in improving the circulation/communication between the Adriatic sea and Vaini lagoon system. Respective sampling stations, coordinates and a brief description of each station are presented in Table-1, while the satellite map of each station is shown in Fig. 1.

**Water analysis:** Chemical and physico-chemical parameters were determined by following the standard methods, according to the Standard Methods for the Examination of Water and Waste Water [6]. Field parameters such as temperature, pH and electrical conductivity were measured *in situ*, while the other parameters like total dissolved solids, total hardness, total suspended solids, calcium, magnesium, chloride, dissolved oxygen, biological oxygen demand and heavy metals were analyzed in the laboratory. Water samples were filtered as soon as arrived to the laboratory and preserved according to their determination procedure. Most of the chemical parameters were analyzed within one week upon their collection.

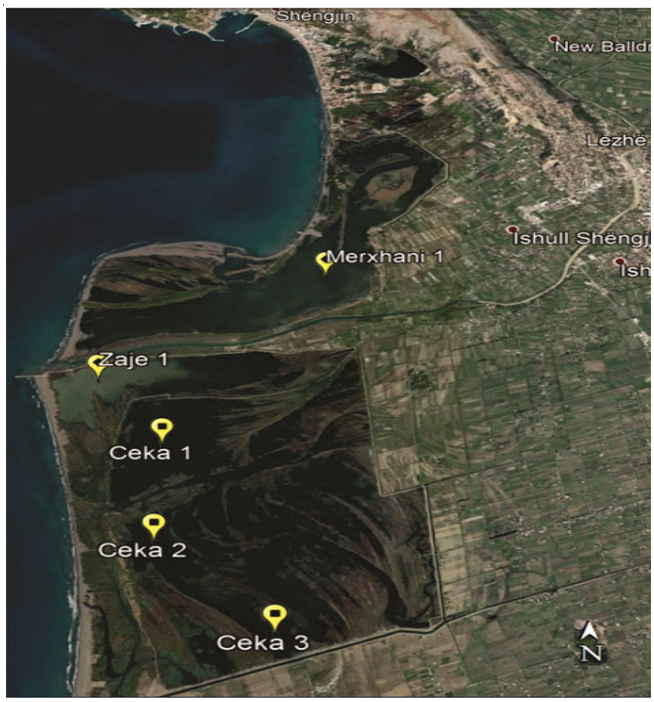


Fig. 1. Map of the sampling stations in Kune-Vain lagoon system

## RESULTS AND DISCUSSION

**Temperature and pH:** Temperature is an important water quality parameter which affect the solubility and availability of dissolved gases such as oxygen and carbon dioxide in water. Water temperature in the present study followed the expected seasonal variation, varying from 1-4 ºC in January 2019 to 24-28 ºC, during September 2018, recorded at Ceka 1. The slight variation between stations were due to the different time of sampling (Table-2). Higher water temperature can reduce the

TABLE-1
SAMPLING STATIONS IN KUNE-VAINI LAGOON SYSTEM

| Station name | Station information | Station latitude | Station longitude |
|---|---|---|---|
| Ceka 1 | Ceka at its northern part, Lezha | 41°44'22.81"N | 19°35'13.66"E |
| Ceka 2 | Ceka at its central part, in front of the new communication tidal channel, Lezha | 41°43'40.00"N | 19°35'16.15"E |
| Ceka 3 | Ceka at its southern part, Lezha | 41°43'3.00"N | 19°36'4.00"E |
| Zaje 1 | Zaje close to the communication channel with the Drini river, Lezha | 41°44'53.95"N | 19°34'43.72"E |
| Merxhani 1 | Merxhani, at its southern part, in front of tidal channel near Kune, Shengjini | 41°45'34.82"N | 19°35'49.25"E |

TABLE-2
RESULTS OF pH AND TEMPERATURE OF WATER

| Stations | Temperature (°C) | | | | | pH | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sept. 2018 | Nov. 18 | Jan. 19 | Mar. 19 | May. 19 | Sept. 2018 | Nov. 18 | Jan. 19 | Mar. 19 | May. 19 |
| Ceka 1 | 28 | 13.2 | 1 | 16 | 23.1 | 7.88 | 7.59 | 7.9 | 8.22 | 8.09 |
| Ceka 2 | 27 | 13.4 | 1 | 16 | 23.1 | 7.65 | 7.69 | 7.86 | 7.91 | 8.15 |
| Ceka 3 | 26.2 | 13 | 1 | 16 | 23.3 | 7.38 | 7.71 | 7.88 | 7.79 | 7.96 |
| Zaje 1 | 24.2 | 13 | 3 | 15.8 | 24.2 | 7.86 | 7.81 | 8.06 | 7.89 | 8.14 |
| Merxhani | 26.2 | 11.4 | 4 | 15.8 | 24.6 | 8.05 | 8.1 | 8.35 | 7.96 | 8.29 |
| Min | 24.2 | 11.4 | 1 | 15.8 | 23.1 | 7.38 | 7.59 | 7.86 | 7.79 | 7.96 |
| Max | 28 | 13.4 | 4 | 16 | 24.6 | 8.05 | 8.1 | 8.35 | 8.22 | 8.29 |
| Average | 26.3 | 12.8 | 2.0 | 15.9 | 23.7 | 7.76 | 7.78 | 8.01 | 7.95 | 8.13 |

dissolved oxygen concentration in water and may thus effect the aquatic organism's life.

The pH of the water samples varied from 7.4-8.4 (Table-2). These variations observed are not significant and the pH ranges obtained fall within the water quality range 6.5-8.5 for any purpose [7].

**TDS, conductivity, salinity:** The conductivity values range from 22.5 mS/cm (Zaje/January 2019) to 61.8 mS/cm (Merxhani/November 2018) (Fig. 2). This fluctuation in conductivity values is related to the geological nature of their water basins. All analyzed waters of Kune-Vaini lagoon exceed the US EPA recommended value of conductivity (1000 µS/cm) for surface waters. Total dissolved solid characterizes the general mineralization of water, which is related to the geological nature of the water source. As can be seen from the obtained results, there is a direct relationship between TDS and electrical conductivity. Fig. 3 represents TDS values for the 5 stations of Kune-Vain lagoon system during the monitoring period. The minimum value of TDS has found in the station Zaje 1, during May 2019, while the maximum value was recorded during the month of November 2018 in the station of Merxhani. Based on these results, it could be said that Kune-Vain complex waters are characterized by a high mineralization.

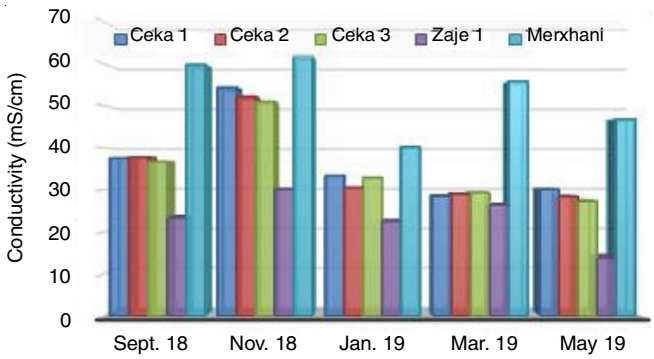


Fig. 2. Seasonal distribution of conductivity

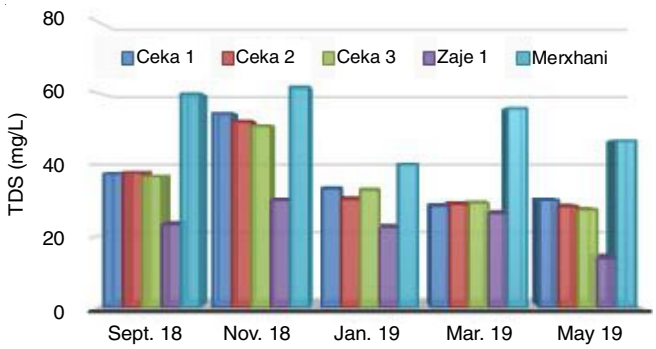


Fig. 3. Seasonal distribution of TDS

Salinity is an important parameter that conditions life in lagoon environments. According to EC 2003 [8] transition waters are classified according to salinity in fresh < 0.5%; oligohaline 0.5 to 5-6%; mesohaline 5-6 to 18-20%, polyhaline 18-20 to 30%; euhaline > 30%. The obtained results have shown a noticeable differences between the water lagoons as well as between the sampling periods (Fig. 4). Higher values were found

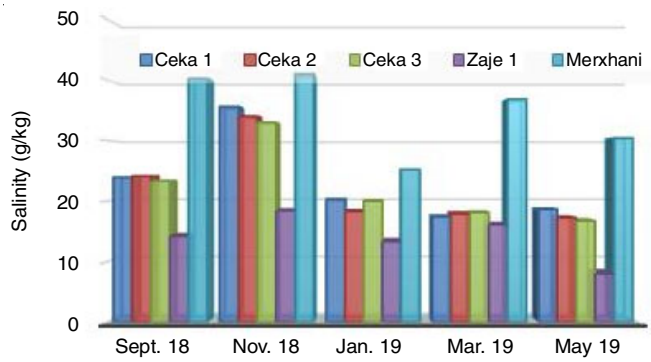


Fig. 4. Seasonal distribution of salinity

in November 2018, while lower values were recorded in January and May 2018, reflected seasonal variations as well as water exchange with the sea. Waters of Vaini lagoon system (Ceka and Zaje) have shown mixohaline characteristics, whereas Merxhani lagoon was characterized by a higher salinity, which was more evident during the summer-autumn period. Based on the results obtained regarding the salinity content the analyzed water samples can be divided into three main groups:

Zaje 1 station with salinity values ranging from 5-18 g/kg, is characterized by low salinity (mesohaline); Stations Ceka 1, Ceka 2 and Ceka 3 are classified as waters with medium salinity (polyhaline, 18-30 g/kg); Merxhani station is characterized by a high salinity and is classified as hypersaline (30-40 g/kg). Merxhani lagoon communicate with sea waters by the south channel that separates the littoral from the island of Kune. Two or more times per year, in wave events, the sea water, overpass the narrow littoral of Merxhani and mixed with lagoon waters. According to Pano [9], the salinity of Ceka lagoon was 9-15 % in the western part (Ceka 3), 8-12 % in the central part (Ceka 1) and 4-5 % in the eastern part. Whereas the salinity in Zaje fluctuated from 9 % near the communication channel with the Drini delta, gradually increasing towards the east up to 23 %. Compared to present data (Fig. 4), it is observed that salinity was increased in Ceka lagoon (16-34 %) and decreased in Zaje lagoon (8-18 %). Despite being separated by a strip of land, the lagoons of Ceka and Zaje have communicated with each other through two artificial canals, which after the 1990s were closed [4]. Consequently, only the Zaje lagoon is under the influence of the Drini waters, which results with low salinity.

**Oxygenation (DO, BOD):** Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land [10]. The dissolved oxygen content in the Kune-Vaini lagoon system waters varies from 6.31 mg/L in Zaje 1 (May 2019) to 16.44 mg/L in Merxhani lagoon (January 2019). Based on these results, the sampled waters at all stations throughout the monitoring period are within the limits recommended by the EU Directive [78/659/EEC] [11]. Higher levels of dissolved oxygen were found during January 2019. In shallow aquatic environments such as Kune-Vain complex, dissolved oxygen will remain at 100% air saturation, a process, which is accelerated by wind or by photosynthesis, *etc.* [10]. Oxygen saturation values (DO%) are generally below 100%; this is evidence of high respiration by aquatic life and microbial decom-

position; observed for Ceka lagoon during November 2018, January and May 2019, for Zaje lagoon during November 2018, March and May 2019 and for Merxhani lagoon during March 2019 (Fig. 5).

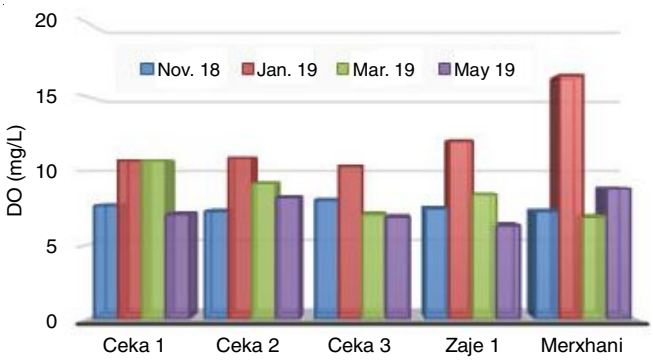


Fig. 5. Spatial distribution of DO

The analyzed water samples showed BOD values ranging from 0.95 mg/L in Ceka 3 during January 2019 to 8.79 mg/L $O_2$ in Merxhani during January 2019 (Fig. 6). The Council Directive 78/659/EEC [11] on the quality of fresh waters require protection or improvement in order to support fish life recommends BOD levels ≤ 3 mg/L$O_2$ for salmonid waters and ≤ 6 mg/L$O_2$ for cyprinid waters. Based on these results almost 85% of the analyzed waters fulfill this criteria.

**Metal and Non-metal ions:** Results of the metal and non-metal ions such as $Ca^{2+}$, $Mg^{2+}$ and $Cl^-$ are presented in Table-3. The level of calcium in water depends mainly on the nature of the limestone rocks [12]. The calcium content in the analyzed samples varied from 133 mg/L at Zaje lagoon during May 2019 to 501 mg/L at Merxhani lagoon during September 2018. The relatively high content of calcium ions in Merxhani lagoon evidences the impact of the waters of the Knalla karst springs,

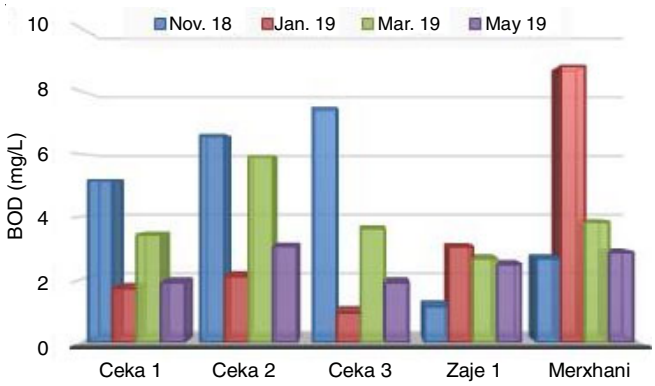


Fig. 6. Spatial distribution of BOD

discharged to the east by the pumping station of the Shengjini Island [5]. The same changes were observed also for magnesium and chloride content. The magnesium content was almost three times higher than calcium content; it indicates stable hardness or otherwise called non-carbonate hardness. High levels of chlorides were found in the waters of Kune-Vain lagoon complex due to regular water exchange with the sea. The maximum value of the chloride content was 24.11 g/L (Merxhani, November 2018) and the minimum content was 5.9 g/L (Zaje 1, May 2019).

**Heavy metals:** Iron was found in higher concentrations in waters of Kune Vaini lagoon, ranging from 2.88 µg/L (Ceka 2/July 2018) to 22.6 µg/L (Ceka 2/January 2019). EPA recommended values range from 0.2-2.0 mg/L for drinking water and surface water, respectively. Levels of iron in waters of Kune-Vaini lagoon system have resulted to be below the recommended values (Fig. 7a).

Higher levels of chromium were found during September and November, 2018. Waters of Vain lagoon (Ceka 1,2,3) are characterized by higher levels of chromium. EPA recommended value for chromium levels in drinking and surface waters is 50

TABLE-3
RESULTS OF METAL AND NON-METAL IONS IN KUNE-VAINI LAGOON COMPLEX

| Stations | $Ca^{2+}$ (mg/L) | | | | | $Mg^{2+}$ (mg/L) | | | | | $Cl^-$ (g/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sept. 2018 | Nov. 18 | Jan. 19 | Mar. 19 | May. 19 | Sept. 2018 | Nov. 18 | Jan. 19 | Mar. 19 | May. 19 | Sept. 2018 | Nov. 18 | Jan. 19 | Mar. 19 | May. 19 |
| Ceka 1 | 259.2 | 407.6 | 203.8 | 199.1 | 202.4 | 824.7 | 1285.4 | 610.5 | 676.7 | 673.5 | 13.0 | 20.2 | 9.9 | 10.9 | 11.7 |
| Ceka 2 | 270.2 | 398.5 | 199.1 | 194.3 | 184.0 | 854.2 | 1204.8 | 699.7 | 679.6 | 628.8 | 14.0 | 19.6 | 11.1 | 10.9 | 11.1 |
| Ceka 3 | 272.1 | 389.3 | 189.6 | 203.8 | 179.4 | 875.3 | 1179.7 | 642.1 | 685.3 | 592.4 | 14.2 | 19.8 | 9.6 | 10.8 | 10.7 |
| Zaje 1 | 233.6 | 242.7 | 194.3 | 199.1 | 133.4 | 495.3 | 592.6 | 501.0 | 636.4 | 293.4 | 8.5 | 10.1 | 8.2 | 10.0 | 5.9 |
| Merxhani | 501.1 | 471.7 | 317.6 | 355.5 | 317.4 | 1420.7 | 1452.4 | 912.8 | 1405.2 | 1056.3 | 23.8 | 24.1 | 15.4 | 22.4 | 18.6 |
| Min | 233.6 | 242.7 | 189.6 | 194.3 | 133.4 | 495.3 | 592.6 | 501.0 | 636.4 | 293.4 | 8.5 | 10.1 | 8.2 | 10.0 | 5.9 |
| Max | 501.1 | 471.7 | 317.6 | 355.5 | 317.4 | 1420.7 | 1452.4 | 912.8 | 1405.2 | 1056.3 | 23.8 | 24.1 | 15.4 | 22.4 | 18.6 |
| Average | 307.2 | 382.0 | 220.9 | 230.4 | 203.3 | 894.0 | 1143.0 | 673.2 | 816.6 | 648.9 | 14.7 | 18.8 | 10.8 | 13.0 | 11.6 |

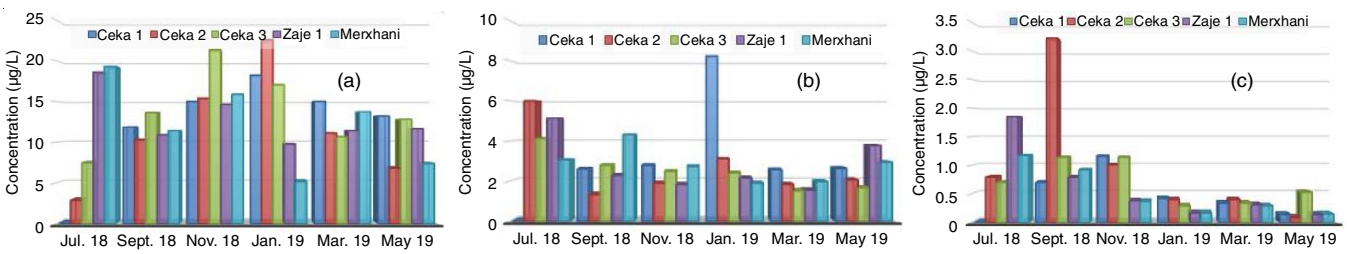


Fig. 7. Seasonal distribution of iron (a), copper (b) and chromium (c)

µg/L. The concentration of chromium in waters of Kune-Vaini lagoons fall below the recommended value (Fig. 7c). Copper content in the water of Kune-Vain complex range from 1.3 µg/L at Ceka 2 (September 2018) to 8.3 µg/L at Ceka 1 (January 2019). The highest levels of copper contents have found during July 2018 in Ceka and Zaje but found decreasing in subsequent monitoring periods (Fig. 7b).

Copper tends to be bound strongly to organic matter and during July, high temperatures lead to high content of organic matter being present in water. The EPA recommended values regarding the copper levels in different water media range from 0.05-1.0 mg/L for surface waters: 0.04 mg/L for fresh waters (Salmonide and Cyprinide waters). Levels of copper in waters of Kune-Vaini lagoons system fall below this recommended values (Fig. 7b).

**Conclusion**

Assessment of physico-chemical parameters and water quality of the Kune-Vaini (Lezha) lagoon complex have been studied. Waters of Kune Vaini lagoon were characterized by high mineralization (high content of EC, TDS, hardness). Significent differences had been observed between the lagoons based on the general physico-chemical parameters measured. High levels of sality, TDS, conductivity, calcium, magnesium and chlorides were found in Merxhani water lagoon. Oxygen saturation (DO%) is generally below 100%, most notably for Ceka and Zaje lagoon, which is evidence of high aquatic respiration and microbial decomposition and limited water exchange. This is also in good compliance with BOD content. Iron was found in higher concentrations in waters of Kune-Vaini lagoon system whilst lead and cadmium resulted to be under the dete-ction limit. The relative abundance of heavy metals in water of Kune-Vaini lagoon followed the order: Fe > Cu > Cr. Water exchange through communication channels with the sea or the Drini river (for Zaje) is necesary for the nutrient circulation, oxygen saturation (DO%) and reduction of BOD. Extreme care is also advised against pollution from the mineral extraction and processing industry of copper and chromium operating within the catchment area.

## ACKNOWLEDGEMENTS

This study has been carried out in the framework of the project "Construction and sustainability of the Kune-Vain lagoon system through access to the ecosystem (EbA)" supported by UNEP, GEF and the Albanian Government.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

## REFERENCES

1. R. Ghai, C. Hernandez, A. Picazo, C.M. Mizuno, K. Ininbergs, B. Díez, R. Valas, C.L. DuPont, K.D. McMahon, A. Camacho and F. Rodriguez-Valera, *Sci. Rep.*, **2**, 490 (2012); https://doi.org/10.1038/srep00490
2. I.A. Lillebø, P. Stalnacke and D.G. Gooch, (2015): Coastal Lagoons in Europe: Integrated Water Resource Strategies. 256 f. https://www.iwapublishing.com/.
3. A. Anthony, J. Atwood, P. August, C. Byron, S. Cobb, C. Foster, C. Fry, A. Gold, K. Hagos, L. Heffner, D.Q. Kellogg, K. Lellis-Dibble, J.J. Opaluch, C. Oviatt, A. Pfeiffer-Herbert, N. Rohr, L. Smith, T. Smythe, J. Swift and N. Vinhateiro, *Ecol. Soc.*, **14**, 8 (2009); https://doi.org/10.5751/ES-02719-140108
4. Anonymous (2017): EIA Report Assessment of environmental impacts of the SCCF project's interventions "Building the resilience of Kune - Vaini Lagoon (KVL) through ecosystem-based adaptation (EbA)". GBA, Green Business Albania. 148 f. http://kunevain.com/wp-content/uploads/2018/09/VNM-Repor-Anglisht-ilovepdf-compressed.pdf.
5. A. Miho, L. Kashta and S. Beqiraj, (2013): Between the Land and the Sea - Ecoguide to discover the transitional waters of Albania. Julvin 2, Tiranë. 462 f. http://www.fshn.edu.al/home/publikime-shkencore.
6. APHA/AWWA (2017): Standard Methods for the Examination of Water and Wastewater. 23rd Edition. Editors: Rice W.E., Baird B.R., Eaton D.A. American Public Health Association, American Water Works Association, Water Environment Federation Publication.
7. World Health Organization (WHO), pH in Drinking-Water; Background Document for Preparation of WHO Guidelines for Drinking-Water Quality, Geneva, World Health Organization (WHO/SDE/WSH/03.04/12) (2003).
8. European Commission, Guidance Document No. 5. Transitional and Coastal Waters; Typology, Reference Conditons and Classification Systems, Working Group 2.4 -COAST, Luxemburg, Office for Official Publications of the European Communities (2003)
9. N. Pano, (1998): Conservation and wide Use of Wetlands in the Mediterranean Basin. Focused in Kune Vain Lagoon, Hydrological regime, Tirana, Albania
10. Anonymous (2013): Dissolved Oxygen. Fundamentals of Environmental Measurements. FondriestEnvironmental,Inc.https://www.fondriest.com/environmental measurements/parameters/water-quality/dissolved-oxygen/.
11. Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life.