Study on the Evaluation of (Heavy) Metals in Water and Sediment of Skadar Lake (Montenegro), with BCF Assessment and Translocation Ability (TA) by *Trapa natans* and a Review of SDGs

Marijana Krivokapić

Faculty of Natural Science, Department of Biology, University of Montenegro, 81000 Podgorica, Montenegro; mari.krivokapic.mne@gmail.com

Abstract: Skadar Lake is a crypto-depression, a shallow lake, near to the Adriatic coast; the largest in the Balkan Peninsula and in southeastern Europe. The Lake is a very complex aquatic ecosystem in which anthropogenic activities have a long history in terms of the impact on wildlife and the overexploitation of natural resources. Such consequences related to heavy metals represent a global problem. Heavy metal pollution can cause severe ecological consequences in aquatic ecosystems. These pollutants accumulate in the aquatic biota from water, sediment and through the food chain, the impact can magnify. Aquatic macrophytes are good indicators of the health of a water body. This research was carried out to evaluate heavy metals concentration in water, sediment and in the aquatic macrophyte *Trapa natans* (water chestnut), with BCF (bio-concentration factor), BSAF (biota sediment accumulation factor) and TA (translocation ability), in order to determine the water quality of this specific part of the aquatic ecosystem of Skadar Lake near to the settlement of Vranjina, a fishing village. The determination of heavy metals was carried out by ICP-OES. (Inductively coupled plasma-optical emission spectrometry). Statistical analysis was established by R statistical computing software, version 3.5.3. The metal concentration in the water decreases in the following sequential order: As > Pb > Zn > Cu = Al = Cr > Cd = Hg. Meanwhile in the sediment, the descending sequence is as follows: Cr > Zn > Cu > Pb > As > Cd > Hg. The ability of plants to absorb and accumulate metals from the aqueous growth medium was assessed using a bio-concentration factor. The BCF in the stem, leaf and fruit has high values, mainly, of Al, Cr, Cu and Zn, while for the biota sediment accumulation factor, the highest values were recorded for the following elements: Hg, Cd, Cu and Zn. Analysis of the translocation ability of TA shows the dominance of four metals: Pb, Cd, Hg and As. A significant positive Kendall’s correlation coefficient between sediment and stem (R = 0.73, p < 0.05), stem and leaf (R = 0.87, p < 0.05) and leaf and fruit (R = 1, p < 0.05) was established.

Keywords: *Trapa natans*; heavy metals; Skadar Lake; BCF; BSAF; TA

1. Introduction

Skadar Lake is a trans-boundary body of water, located on the border between Montenegro (MNE) (4460 km²) and Albania (AL) (1030 km²) wetland (it is included in the Ramsar list of wetlands of international importance no.784/1996, and has been a National Park from 1983). The Committee of the Berne Convention nominated Skadar Lake, on 2 December 2011, as an EMERALD area. According to the criteria of the Bern Convention, 17 EMERALD habitats have been identified in the area of Skadar Lake (areas where wild flora and fauna and their natural habitat have been preserved and according to the delineation set out in entire catchment of the Lake is in the Ecoregion 5 category. The drainage basin of Lake Skadar is part of the Adriatic Sea drainage basin. The Lake extends in the NW-SE direction. Its size varies seasonally and is between 360 km² and 500 km² (according to some authors 530 km² even 600 km²). The Lake is 50 km long, a maximum...
of 14 km wide, and the shoreline is 207 km long, at average water-level. The Lake is a crypto-depression. The maximum depth with this water level is 8.3 and it is 5.01 m above sea level, on average. This does not refer to the depth of sublacustric springs (“oka”-“eyes”) that can be as deep as 60 m. The depth of the Lake depends on the water level.

The largest inflow is through the Moraca River and its tributaries (73%), followed by the sublacustric springs (over 17%) and direct precipitation (about 9%). The movement of the water mass is either turbulent, caused by the influx of water from the sublacustric springs and watercourses or they are on the surface, depending on the wind direction and strength [1].

The Lake (Figure 1) represents one of the most diverse ecological areas of south-east Europe (bio-geographical region: Mediterranean). The Lake is a subtropical (it has a mean temperature value of 14.9 °C) and shallow. The ecological status of the Lake can be actually classified as good to moderate.

![Skadar Lake, satellite map, 3 D (source of the image [2]).](image)

**Figure 1.** Skadar Lake, satellite map, 3 D (source of the image [2]).

Research for this study was conducted near to the settlement of Vranjina. This settlement is located on one of the fifty islands on Skadar Lake. In fact, Vranjina used to be an island, the largest and the highest on the lake. This small fishing village is today connected to the mainland by an embankment on both sides and has been turned into a peninsula. Vranjina is one of the oldest villages/settlements on Skadar Lake. It is located at about 11 m above sea level [1–6].

The sources of pollution of Skadar Lake (concentrated point sources) are mostly industrial and municipal sewage, waste water treatment plant outflow, and other dispersed non-point sources, bring contaminated substances from larger surfaces: agriculture, irrigation, by runoff of atmospheric precipitation, flooding, etc. The main non-point sources of pollution are washout from farming areas with significant amount of fertilizers, pesticides, and bio-stimulators forming an integral portion or in the form of residue. Similar pollution is present in water used for irrigation, which penetrates both surface and underground waters. Skadar Lake has shown a tendency of increasing pollution and eutrophication [1,7–9].

Submerged, floating and emergent aquatic macrophytes are a striking feature of Skadar Lake. They are significant producers of organic matter, play an important role in food cycles in this ecosystem, and provide specific habitats for many inhabitants of the Lake. The areas covered by aquatic macrophytes increase from year to year, which can be best seen by comparing old maps (orographic maps 1: 25,000), satellite images and data collected in recent years. This is a clear indicator of the eutrophication of the Lake. *Trapa natans* L. (water chestnut) is a small free-floating plant growing mainly in shallow water. The fruits are nutritious, astringent, cooling, diuretic and tonic. The fruits have many healing effects
and the whole plant has various positive pharmacological effects. Many studies confirm that the fruits of *Trapa natans* are an important source of chemical substances with potential therapeutic effects. The whole herb has been noted for its antibacterial activity, antifungal activity, anti-inflammatory activity, neuro-protective effect, hepatic protective activity, immune modulator activity, etc. [10–16].

Heavy metals pollution: The pollution of the aquatic environment with heavy metals has become a worldwide problem of serious concern [17]. The term “heavy metals” is often used as a group name for metals and metalloids that have been associated with contamination and potential toxicity or ecotoxicity. Heavy metals are considered as hazardous chemicals in the environment [18].

Heavy metal uptake by plants from water and sediments, which are either anthropogenically contaminated or naturally rich in heavy metals, is a problem in many parts of the world [19]. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems. Since heavy metals are persistent in the environment, they accumulate in living organisms and are transferred from one trophic level to another in the food chains. The trophic transfer of these elements in aquatic and terrestrial food chains/webs has important implications for wildlife and human health [18].

Regulations and Selection of heavy metals for this research: Classification and categorization of surface and groundwater on land and coastal sea waters in Montenegro is performed on the basis of the Regulation on the manner for determining the status of surface water (Official Gazette, 5/2011, 32/11, 48/15, 52/16 and 84/18) [20] and on the basis of the Rulebook on the Classification and Categorization of Surface and Groundwater (Regulation Official Gazette of Montenegro, 02/07) [21]. For these study cadmium, mercury and lead were chosen because there are classified as priority hazardous substances, while copper, zinc, chromium, arsenic were chosen, because they are classified as specific pollutants. Aluminum was chosen because it is known as toxic to a wide range of aquatic ecosystems.

Regulation on the Categorization of the Hazardous Substances in Water (Official Gazette, 5/2011.) 32/11, 48/15, 52/16 and 84/18) was used for determination of chemical and ecological status in accordance with Environmental quality standards, EQS (for priority substances (PS), priority hazardous substances (PHS) and specific pollutants (SP). According to this Regulation values of metals in the surface waters: are cadmium 0.04 µg/L, mercury 0.0025 µg/L, copper 1.0 µg/L, chromium 1.2 µg, zinc 4.2 µg/L [20]. The Rulebook on the Classification and Categorization of Surface and Groundwater (Official Gazette of Montenegro, 02/07) [21] was used to compare research data. Values of metals concentration due to this rulebook are, for cadmium 0.005 mg/l, mercury 0.005, copper 0.05, zinc 1.0, lead, 0.005 mg/L, arsenic 0.05 mg/L, and for aluminum there is no concentration value for inland waters, except for the value given for the concentration in wastewater in the amount of 3.0 mg/L (water body of category I) and 3.5 mg/L (water body of the second category A2). Water of Skadar Lake is classified in A2 CK2 class.

The values of the analysed metals in the aquatic macrophyte *Trapa natans* were compared with the metal concentrations according to Codex Alimentarius, CF/5, INF/1, 2011, toxicological guidance value [22]. The value for cadmium is: 0.01–0.1 mg/kg; copper from 0.1 to 0.4 mg/kg; no concentrations given for chromium; zinc 0.3–1 mg/kg; lead 0.1 to 0.3 mg/kg; arsenic, aluminum 1 mg/kg, Official Gazette, no 57/15 pp 19): cadmium 0.05; lead 0.1, 0.20, 0.50 and mercury 0.05 in food (no values given for other metals) [23].

The values of the analysed metals in sediment were compared with the metal concentrations according to the Canadian and Dutch sediment quality guidelines [24,25]. Canadian sediment quality guidelines for the protection of aquatic life, for sediment quality are derived from available environmental information on the biological effects of compounds or elements in sediment. The values of the Canadian recommendations are given in two categories: the theoretically possible value of the impact, and the empirically probable value of the impact. The Dutch recommendations also have two values: the *intervention*
value and the target value. Metal concentrations according to Canadian regulations: a. theoretically possible impact value: Cd (0.6 mg/kg); Hg (0.17 mg/kg); Cu (35.7 mg/kg); Cr (37.3 mg/kg); Zn (123 mg/kg); Pb (35 mg/kg); As (5.9 mg/kg); b. empirically probable effect value: Cd (3.5 mg/kg); Hg (0.49 mg/kg); Cu (197 mg/kg); Cr (90.0 mg/kg); Zn) (345 mg/kg); Pb (94.3 mg/kg); As (17.0 mg/kg). In accordance with Dutch regulations, the following metal concentrations are given: a. intervention value: Cd (12. mg/kg); Hg (10.0 mg/kg); Cu (190 mg/kg); Cr (380 mg/kg); Zn (720 mg/kg); Pb (530 mg/kg); As (55.0 mg/kg); b. target value: Cd (0.8 mg/kg), Hg (0.3 mg/kg), Cu (36.0 mg/kg), Cr (100 mg/kg), Zn (140 mg/kg), Pb (85 mg/kg), As (29.9 mg/kg) [24,25].

The aim of this research has been to analyse (heavy) metals, namely Pb, Cd, Cu, Zn, Al, Cr, Hg, As in the water, Pb, Cd, Cu, Zn, Cr, Hg, and As in sediment of Skadar Lake (near to the settlement of Vranjina fishing village), Pb, Cd, Cu, Zn, Al, Cr, Hg, and As in water chesnut (Trapa natans) in stem, leaves, and fruits, differences and the degree of BCF (Pb, Cd, Cu, Zn, Al, Cr, Hg, As,) and BSAF (Pb, Cd, Cu, Zn, Al, Cr, Hg, As) in different parts of this aquatic macrophyte, especially in the fruit, which is used in the diet of the local population, and the translocation ability (TA) of Trapa natans (Pb, Cd, Cu, Zn, Al, Cr, Hg, As). Moreover, we provide an analysis of the presence of heavy metals concentration in all matrices, in order to determine the actual state of water and sediment quality data of this location (with the chemical and ecological status) and with the review of sustainable development goals (SDGs).

2. Materials and Methods
2.1. Study Area and Research Methodology

All samples were collected in the area near by settlement (Figures 2 and 3) Vranjina (42°16′25″ N, 19°08′02″ E) Skadar Lake. For the purpose of this research, water samples are collected at the depth of 0.5 m, from the water surface. Collected samples of 1 L, were bottled and saved in handheld refrigerator and transferred to the laboratory.

![Sampling location, near to settlement Vranjina (fishing village), Skadar Lake.](image)

Sediment. The sediment samples were taken by Ekman dredge, from the depth of 0–20 cm, packed in plastic boxes and transported to the laboratory. Samples of Trapa natans (stems, leaves and fruits) were taken from the same locality near by the settlement of Vranjina (Skadar Lake) in an area with a high density of this aquatic plant. Plants of similar size, shape and weight were packed in polyethylene bags, saved in refrigerator 5 ± 2 °C) and transferred to the laboratory.
Figure 3. Sampling location of *Trapa natans* (a) (near to settlement Vranjina, Skadar Lake) and fruit (b).

### 2.2. Laboratory Analyses, Instrumental Methods/Techniques

Laboratory analyses for water and *Trapa natans* was done in the Chemical laboratory of Institute for Public Health in Podgorica, Montenegro. The content of heavy metals in water samples (previously acidified to pH < 2) was directly determined using the ICP-OES technique (induced coupled plasma optical emission spectrometer). Operating wavelengths and practical limits of quantification are shown on Table 1 and results of metals analysis in sediment and in reference material with extended measurement uncertainty (CRM) and limit of quantification (LOQ) of the method are shown on Table 2.

#### Table 1. Operating wavelengths and practical limits of quantification.

| Metals | Working Wavelength | PQL (mg/L) |
|--------|--------------------|------------|
| Pb     | 283.3              | 0.005      |
| Cd     | 228.8              | 0.001      |
| Cu     | 324.8              | 0.001      |
| Zn     | 213.9              | 0.002      |
| Al     | 308.2              | 0.005      |
| Cr     | 357.9              | 0.002      |
| Hg     | 225.6              | 0.0005     |
| As     | 224.5              | 0.0005     |

#### Table 2. Results of metals analysis in sediment from Skadar Lake (near the settlement Vranjina) and in reference material with extended measurement uncertainty (CRM) and limit of quantification (LOQ) of the method.

| Parameter/Metal | Value (mg/kg) | Result of Analysis CRM (mg/kg) | Certified Value CRM (mg/kg) | LOQ (mg/kg) |
|-----------------|---------------|--------------------------------|-----------------------------|-------------|
| Lead (Pb)       | 12 (±1)       | 135.1 ± 11.3                   | 132.8 ± 1.1                 | 1           |
| Cadmium (Cd)    | 0.26 (±0.03)  | 0.820 ± 0.094                  | 0.817 ± 0.011               | 0.2         |
| Copper (Cu)     | 41 (±4)       | 110.5 ± 10.8                   | 117.7 ± 5.6                 | 0.2         |
| Zinc (Zn)       | 84 (±8)       | 480.3 ± 45.7                   | 485.3 ± 4.2                 | 0.2         |
| Mercury (Hg)    | 0.08 (±0.01)  | 0.4465 ± 0.0058                | 0.4474 ± 0.0069             | 0.001       |
| Chromium (Cr)   | 111 (±8)      | 329.8 ± 23.7                   | 352 ± 22                    | 0.2         |
| Arsenic (As)    | 7 (±1)        | 42.2 ± 6.0                     | 45.3 ± 1.8                  | 2           |

Determination of metal content in the *Trapa natans* was performed according to the methods AOAC 985.01 (for Pb, Cu, Zn, Al, As and Cr) and AOAC 982.23 (for Cd), while mercury content in water and *Trapa natans* samples was performed by Direct Mercury Analyzer (Shimadzu Corporation, Shimadzu, Japan). Preparation of samples was carried out by microwave digestions according to Montenegrin standard MEST EN 13805: 2009. The measured amount (0.1–0.5 g) of sample was transferred to a digestion vessel and poured with 5 mL of concentrated HNO₃ and left to react overnight. After that, 2 mL of H₂O₂ were added for further oxidation and decomposition remaining substances in
order to achieve complete mineralization. Samples were digested under high pressure and temperature in accordance with the microwave oven manufacturer’s recommendation, samples are transferred to volumetric flasks and filled up to 25 mL with distilled water.

Calibration curves on ICP-OES and AAS (Cd and Pb) for determination of metals in water and *Trapa natans* were constructed using solutions prepared by diluting stock standard solutions 1000 mg of each element per L, manufactured by BT Baker. Operating wavelengths and PQL values for analyzed metals are given in the Table 1. Determination of metal content in the sediment was performed according to the method of EPA 3051 (https://www.epa.gov/labs/laboratory-methods, accessed on 10 March 2021, Washington, DC, USA). The measured amount (0.3–0.5 g) of the homogenized sample was transferred to a digestion vessel. Then, 9 mL of concentrated nitric acid and 3 mL of concentrated hydrochloric acid were added. The vessel was closed and placed in a microwave oven for welding. Digestion was done according to the temperature program recommended by the manufacturer for the SW Xpert, (Berghof Products + Instruments GmbH, Eningen, Germany). After digestion, the cooled solution from the vessels (with filtration) was transferred to volumetric flasks (25 mL) and supplemented up to the mark with deionized water. In the prepared samples, the analysis of the metal content was determined using ICP-OES, Thermo iCAP7400 (Thermo Fisher Scientific, Waltham, MA, USA).

For calibration were used solutions prepared by diluting stock standard solutions 1000 mg of each element per L produced by Sigma Aldrich (Sigma Aldrich, St. Louis, MO, USA). Together with the samples, the reference material Inorganic in Marine Sediment (NIST 2702) (https://www.nist.gov/about-nist/contact-us, accessed on 10 March 2021, Gaithersburg, MD, USA) was prepared and analyzed. Mercury content in the sediment samples was determined using an Advanced Mercury Analyzer, AMA-254, Leco (Leco Corporation, St. Joseph, MI, USA).

Analysis of sediment CRM (reference material with extended measurement uncertainty) and LOQ (limit of quantification) has been established in EcoToxicological Center (Table 2). A confidence level of 95% was used, k = 2 (expanded measurement uncertainty).

2.3. Statistical Analyses

2.3.1. Bioconcentration Factor (BCF)

Several terms are used to define the concentration of elements in aquatic biota. Thus, bioconcentration is the intake of an element into biota when the source of the elements is water itself. It is expressed as a bioconcentration factor (BCF) that shows the ratio of the concentration of an element in the plant to the concentration of the element in water. Bioconcentration denotes how much the concentration of a certain element is higher in biota in relation to the concentration of that element in the environment, i.e., BCF is defined as the uptake of contaminants from the dissolved phase. It can be calculated by the following equation:

\[ BCF = \frac{C_B}{C_w} \]  \hspace{1cm} (1)

\[ BCF = \frac{\text{Metals (part of aquatic plant)}}{\text{Metals (water)}} \]  \hspace{1cm} (2)

where C represents the average concentration of the element in the biota i.e. a certain tissue (µg/g of moist mass), and Cw concentration of the element in water (µg/mL). Higher BCF values imply a greater bioaccumulation capability.

2.3.2. Biota Sediment Accumulation Factor (BSAF)

Biota sediment accumulation factor is defined as the concentration of contaminant uptake by biota from matrices (sediment).

\[ BSAF = \frac{C_B}{C_S} \]  \hspace{1cm} (3)
where \(C_B\) represents the average concentration of the element in the biota i.e., a certain tissue (µg/g of moist mass), and \(C_S\) refers to the concentration of the element in the sediment (µg/g).

2.3.3. Translocation Ability (TA)

Translocation ability were calculated as the ratio of the concentrations of metals in stem and leaves, i.e., in the stem and fruit. TA of (heavy) metal(s) within aquatic plant were calculated as shown below:

\[
TA = \frac{\text{Metal}_{\text{stem}}}{\text{Metal}_{\text{fruit}}} \quad \text{and} \quad TA = \frac{\text{Metal}_{\text{stem}}}{\text{Metal}_{\text{leaf}}}
\]

(4)

where TA (translocation ability) is used to determine a plant’s potential for the translocation of metals (µg/g). Higher TA value means a higher translocation ability [26–31].

2.3.4. Chemical and Ecological Status

Assessment of the chemical status of Priority hazardous substances (PHS) was based on the concentration of the following metals: cadmium (Cd), mercury (Hg) and lead (Pb) priority substance (PS) in relation to MPC (maximum permissible concentrations) for surface waters [20,21]. To determine the ecological status, the concentrations of the following metals: copper (Cu), zinc (Zn), chromium (Cr), and arsenic (As) were compared in relation to MPC + NC (natural concentration) which are within the EQS (environmental quality standards) as specific pollutants (SP) [20,21].

2.3.5. Kendal’s Tau Coefficient-Kendal Rank Correlation Coefficient

Kendal’s Tau coefficient–Kendall rank correlation coefficient was chosen for this research, because Kendall rank correlation (non-parametric) is an alternative to Pearson’s correlation (parametric) when the data working with has failed one or more assumptions of the test. Kendal’s Tau Coefficient is a good alternative to Spearman correlation (non-parametric) when sample size is small or has many tied ranks.

The Kendall tau coefficient (or Kendall correlation coefficient) is defined as:

\[
\tau = \frac{\text{number of matching pairs} - \text{number of disagreeing pairs}}{\frac{1}{2}N(N-1)}
\]

(5)

In this research, \(\tau\) is the R value on the Figures. Statistical analysis has been done in R statistical computing software [31,32] version 3.5.3.

3. Results

The levels of (heavy) metals in water and in \(T. \) natans-water chesnut (stem, leaf, fruit) is shown on the Table 3. By analysing the (heavy) metals concentration, dominant position of the next three metals: As > Pb > Zn in the water (of Skadar Lake, nearby settlement Vranjina) were determined. Copper, aluminium, and chromium have equal values (Cu = Al = Cr), as does cadmium and mercury Cd = Hg. Among analysed (heavy) metals in sediment, increasing concentrations (related to potential toxicity) is indicated for the next four metals: Cr (111 mg/kg), Zn (84 mg/kg), Cu (41 mg/kg) and As (7 mg/kg). The descending sequence of metals in the sediment is as follows: Cr > Zn > Cu > Pb > As > Cd > Hg (Table 4).
Of all analysed metals in *Trapa natans* the highest level for aluminium (Al) has been established: in the leaf (89.43 mg/kg), then in the fruit (28.53 mg/kg) and in the stem (26.6 mg/kg). At the subdominant position is Zn (1.13 mg/kg), in leaf and in the fruit (1.03 mg/kg).

Minimum values of the metal concentration in stem, leaf and in fruit were determined for the next four metals: Pb, Cd, Hg and As. Degree of metal concentration follows this order, in the stem: Al > Zn > Cr > Cu > Pb = Hg = As = Cd; leaf: Al > Zn > Cu > Cr > As = Hg = Pb = Cd and fruit: Al > Zn > Cu > Cr > Pb = Cd = Hg = As.

Summary of Kendall’s correlation coefficient (stem, leaves, fruits, sediment) is shown on Table 5. The Kendall correlation coefficient between stem and leaf (Figure 4a) is $R = 0.87$ ($p = 0.016$), representing a significant positive coefficient, as well as the same between stem and fruit (Figure 4d). Kendall correlation between stem and sediment is presented on Figure 4b with coefficient of $R = 0.73$ ($p = 0.029$). This indicates a positive relationship between the ranks concentration stem and sediment. The highest degree of the determined Kendall correlation is observed between the leaf and fruit $R = 1$ ($p < 0.054$) (Figure 4c).

### Table 3. Results of metal analysis in the water (near the settlement Vranjina), and in water chestnut (stem, leaf, fruit).

| Samples (mg/L, mg/kg) | Pb  | Cd  | Cu  | Zn  | Al  | Cr  | Hg  | As  |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Lake/Water            | <0.005 | <0.0005 | <0.002 | 0.004 | <0.002 | <0.002 | <0.0005 | <0.01 |
| *Trapa natans* steam  | <0.01 | <0.01 | 0.21 | 0.37 | 26.6 | 0.27 | <0.01 | <0.01 |
| *Trapa natans* leaf   | <0.01 | <0.01 | 0.85 | 1.13 | 89.43 | 0.61 | <0.01 | <0.01 |
| *Trapa natans* fruit  | <0.01 | <0.01 | 0.69 | 1.03 | 28.53 | 0.30 | <0.01 | <0.01 |

### Table 4. Results of metal analysis in the sediment of Skadar Lake (near the settlement Vranjina).

| Parameter/Metal | Value (mg/kg) |
|-----------------|---------------|
| Lead (Pb)       | 12            |
| Cadmium (Cd)    | 0.26          |
| Copper (Cu)     | 41            |
| Zinc (Zn)       | 84            |
| Mercury (Hg)    | 0.08          |
| Chromium (Cr)   | 111           |
| Arsenic (As)    | 7             |

### Table 5. Summary of Kendall’s correlation coefficient (stem, leaves, fruits, sediment).

|       | Stem | Leaf | Fruit | Sediment |
|-------|------|------|-------|----------|
| Stem  |      | 0.867 * | 0.867 * | 0.732 * |
| Leaf  | 0.867 * |      | 1.000 ** | 0.620    |
| Fruit | 0.867 * | 1.000 ** |      | 0.620    |
| Sediment | 0.732 * | 0.620 | 0.620 |      |

* indicates that $p$ is a value of 0.01–0.05; ** indicates that the $p$-value is between 0.001–0.01.
Figure 4. (a) Kendall correlation, stem and leaf; (b) Kendall correlation, stem and sediment; (c) Kendall correlation, leaf and fruit; (d) Kendall correlation, stem and fruit.
3.1. Bioconcentration Factor (BCF)

The ability of a plant to bioconcentrate showed the dominance of the next four metals in stem: aluminum (1330), chromium (135), copper (105) and zinc (92.5). The highest BCF in leaves has been established for: aluminum (44715), copper (425), chromium (305) and zinc (282.5) and in the fruits, the bioconcentration factor is also dominated by aluminum (1426.5), then with copper (345). Cadmium and mercury have the same values in all parts of the plants as lead and arsenic, but in much lower concentrations (Table 6).

| Metals | Stem | Leaf | Fruit |
|--------|------|------|-------|
| Pb     | 2    | 2    | 2     |
| Cd     | 20   | 20   | 20    |
| Cu     | 105  | 425  | 345   |
| Zn     | 92.5 | 282.5| 257.5 |
| Al     | 1330 | 44715| 14265 |
| Cr     | 135  | 305  | 150   |
| Hg     | 20   | 20   | 20    |
| As     | 1    | 1    | 1     |

The level of BCF in the stem decreases by the following sequential order: Al > Cr > Cu > Zn > Cd = Hg > Pb > As; in the leaves: Al > Cu > Cr > Zn > Hg = Cd > Pb > As and in the fruits: Al > Cu > Zn > Cr > Cd = Hg > Pb > As.

3.2. Biota Sediment Accumulation Factor (BSAF)

BSAF as represents the average concentration of the (heavy) metals between aquatic plant (in a certain tissue) and sediment is presented on Figure 5. Biota sediment accumulation factor from the highest to the lowest concentration is shown with the following order, in stem: Hg > Cd > Cu > Zn > Cr > Pb = As; in leaves: Hg > Cd > Cu > Zn > Cr > Pb = As; in fruits: Hg > Cd > Cu > Zn > Cr > Pb = As.

Figure 5. BSAF stem, leaf, fruit-sediment.
In contrast to the BCF from water, where Al, Cr, Cu and Zn were dominant. In relation to the concentration of the contaminant uptake by aquatic plant from sediment (BSAF), four different dominant metals (although in much lower concentrations): Hg > Cd > Cu > Zn, were established.

3.3. Translocation Ability (TA)

The ability of plants to conduct metals from stem to leaf and from steam to fruit was assessed using translocation ability (TA). As we can see, from the Table 7, the dominant and same translocation ability $TA_{stem/leaf}$ is for the next four metals: Pb = Cd = Hg = As (TA = 1.0), as well as for the $TA_{stem/fruit}$ (TA = 1.0), Table 8. The other five metals have a lower TA values: As > Cr > Zn > Al > Cu Analysis of stem-fruits shows the ability of water chestnut to translocate metals in different layouts: As > Al > Cr > Zn > Cu.

Table 7. Translocation ability, water chestnut, stem-leaf.

| Metals/Part of Plant | Pb   | Cd  | Cu  | Zn  | Al  | Cr  | Hg  | As  |
|----------------------|------|-----|-----|-----|-----|-----|-----|-----|
| stem                 | <0.01| <0.01| 0.21| 0.37| 26.6| 0.27| <0.01| <0.01|
| leaf                 | <0.01| <0.01| 0.85| 1.13| 89.43| 0.61| <0.01| <0.01|
| TA                   | 1.00 | 1.00| 0.247| 0.327| 0.297| 0.443| 1.00| 1.00|

$TA: Pb = Cd = Hg = As > Cr > Zn > Al > Cu.$

Table 8. Translocation ability, water chestnut, stem-fruit.

| Metals/Part of Plant | Pb   | Cd  | Cu  | Zn  | Al  | Cr  | Hg  | As  |
|----------------------|------|-----|-----|-----|-----|-----|-----|-----|
| stem                 | <0.01| <0.01| 0.21| 0.37| 26.6| 0.27| <0.01| <0.01|
| fruit                | <0.01| <0.01| 0.69| 1.03| 28.53| 0.30| <0.01| <0.01|
| TA                   | 1.00 | 1.00| 0.304| 0.359| 0.932| 0.900| 1.00| 1.00|

$TA: Pb = Cd = Hg = As > Al > Cr > Zn > Cu.$

3.4. Chemical and Ecological Status

Priority hazardous substances (PHS) for determining the chemical status in the water, has been established on the following metals: cadmium (Cd), mercury (Hg) and lead (Pb) priority substance (PS), while to determine the ecological status were used specific pollutants (SP), (within EQS): copper (Cu), zinc (Zn), chromium (Cr) and arsenic (As). The analysis of determined chemical status is bad falling to achieve good, while established ecological status based on the analysis of the (SP) proved to be good (more about chemical and ecological status is given in the chapter Discussion).

4. Discussion

4.1. Water (Heavy) Metal Concentration and Toxicity to Aquatic Plants (Aquatic Biota) and Humans

The chemical composition of Lake water is not often uniform in depth, which depend on seasonal variations and external temperatures factors. Many investigations showed a uniform distribution of chemical parameters from the surface to the bottom owing to the shallowness of Skadar Lake and frequent mixing events [5–7].

Arsenic is ranked the first of all hazardous substances by the Agency for Toxic Substances and Disease Registry As is an element that raises much concern from both environmental and human health standpoints [33,34]. Arsenic (As) is an ubiquitous element, released into the aquatic environment through anthropogenic activities.

The releases originating from human activities (e.g., metal smelting, chemical production and use, coal combustion, waste disposal, pesticide application) are the emissions that can cause substantial environmental arsenic contamination [35]. Exposure to arsenic sufficient to cause severe acute systemic symptoms. The signs and symptoms are somewhat variable in degree and timing and depend on the form and amount. The major characteristics of acute arsenic poisoning are profound gastrointestinal damage and cardiac abnormalities [36]. Exposure of plants to As, even at very low concentration, can cause many morphological, physiological, and biochemical changes. Arsenic uptake by plant
species relies on its total concentration and, importantly, on the speciation of As in sediment, which is thought to be dependent upon exchangeable (bioavailable). Arsenic is considered non-essential for plants and other biota [37]. Arsenic and its inorganic compounds have long been known to be neurotoxic. Arsenic is a potent genotoxic agent for animals and humans that can damage DNA, induces chromosomal aberration. [38,39].

The value of arsenic (As) according to water quality criteria [21] is 0.05 mg/L. The established values of arsenic by this research are less than those determined by the Rulebook (Table 9), [21]. The concentration of As at the confluence of the Moraca River and Skadar Lake (near the research location) was: 0.02 mg/L which shows a double magnification at a very short distance [40].

Table 9. Comparison research data with Rulebook) water quality criteria [21].

| Metals      | Unit | Research Data | Rulebook | < or > |
|-------------|------|---------------|----------|--------|
| Lead        | mg/L | 0.005         | 0.05     | <      |
| Cadmium     | mg/L | 0.0005        | 0.005    | <      |
| Copper      | mg/L | 0.002         | 1.0      | <      |
| Zinc        | mg/L | 0.004         | 0.3–1    | <      |
| Aluminium   | mg/L | 0.002         |          |        |
| Chromium    | mg/L | 0.002         | 0.05     | <      |
| Mercury     | mg/L | 0.0005        | 0.005    | <      |
| Arsenic     | mg/L | 0.01          | 0.05     | <      |

Among the concentrations of hazardous and toxic substances (mg/L) in wastewater samples from a basin of “red mud” (Aluminum Plant) which are allowed to be discharged into surface waters (in Moraca River (the main tributary of Skadar Lake) the concentration of arsenic was determined to be 0.015–0.002 mg/L (sample 1 and 2), which exceeds the maximum allowed concentration according to the Regulation, Official Gazette of Montenegro 9/10), while the maximum concentrations of hazardous and toxic substances (mg/kg) detected in the soil in the area of solid waste disposal sites of Aluminium Plant was 80.70 mg/kg (concentration on the waste disposal site), 12.50 mg/kg (concentration in the soil directly below the waste) and 0.045 mg/kg (concentration in deeper soil layers below the waste). The allowed MPC (Maximum Permissible Concentration) for hazardous and harmful substances in the soil in accordance to Official Gazette is 20 mg/kg [1]. We postulate that the source of arsenic in water was formed by diffuse leaching from these surface as well as from agriculture.

Lead is toxic heavy element, biologically nonessential in the environment. It is ranked the second of all hazardous substances by the Agency for Toxic Substances and Disease Registry [33,34], globally, it is an abundantly distributed. According to its non-biodegradable nature and continuous use, its concentration accumulates in the environment. Absorption of different concentrations of Lead (Pb) and Cadmium (Cd) by aquatic plant was evaluated by Singh et al [41]. Authors stated: Increase in biomass, total chlorophyll, protein and nitrate reductase activity was noticed at lower concentration of both metals whereas at higher metal concentrations of Pb and Cd decrease. In the aquatic environment, lead is accumulated in algae, macrophytes and benthic organisms, where inorganic forms of lead are not subject to biomagnification [41,42].

Lead has adverse effects on certain organ systems like the central nervous system, the system, etc. and has important implications for human health. [43]. Increased Pb concentration causes a number of toxicity symptoms in plants (inhibits photosynthesis, mineral nutrition, etc.).

In this research, the concentration of lead (Pb) in water has subdominant position (Table 3) As > Pb > Zn > Fe > Cu and it is less than natural concentration [21]. Values of concentrations of Pb (mg L⁻¹) in amount of 0.049 in the water of Lake Łebsko fortified by Mrozinska and Bakowska [44]. Investigations of heavy metals in the Montenegrin part of Lake Skadar [45]. showed that the priority was either not detected in water or was below EQS values. [46]. Investigations of concentrations of Pb at three locations in the water of
Skadar Lake, in the amount of 0.001 mg were determined in the study Water Pollution of Skadar Lake [1].

Zinc is widely distributed through the natural environment and is also an essential trace element for aquatic organisms and humans. According to the water quality criteria, issued by the criteria of zinc to protect freshwater aquatic organisms are 120 µg/L (short term hazardous concentration) and 120 µg/L (long-term hazardous concentration) [47]. Aquatic life criteria for toxic chemicals are the highest concentration of specific pollutants or parameters in water, that are not expected to pose a significant risk to the majority of species in a given environment [48].

According to (Regulation Official Gazette, 5/2011. 32/11, 48/15, 52/16 and 84/18), [20]. The value of zinc (Zn) is 4.2 µg/L; due to Rulebook 1.0 mg/L, [21]. Determined value of the Zn in the water of Skadar Lake (near settlement Vranjina) has value of 0.004 mg/L (Table 3) and represents a smaller concentration compared to the one provided by Rulebook [21].

We postulate that origin of the zinc presence in waters and sediment in Moraca River and Skadar Lake mouth could be found in the production processes from the Still industry of Niksic. Dumpsites of the Still industry are potential pollution source for Skadar ke and its tributaries Moraca and Zeta. Various types of unsorted waste are disposed at old (600.000 m³) and new one (825.000 m³) dumpsites of the Still industry. Zinc (Zn) is 15 times of its limit value); as well as the values of zinc concentration also are from the waste disposal site “red mud”, of the Aluminum Plant [49].

The value of zinc (Zn) in the water of Moraca river mouth (near settlement Vranjina) was on the fourth place: F > Fe > Al > Zn). A survey during 2018. established a value of 0.02 mg/L, which shows a double magnification [40]. Research of Zn in the water of Skadar Lake, by season, had the following values: for spring season (April), from 0.002 to 0.008 mg dm⁻³, summer, (June) 0.002 to 0.007 mg dm⁻³, and autumn season (October), from 0.002 to 0.008 mg dm⁻³ [50].

Copper is readily accumulated by plants and animals (bioconcentration factors have been recorded for various species of phytoplankton, zooplankton, macrophytes, macroinvertebrates and fish). Copper is an essential trace element required by most aquatic organisms, but toxic concentrations are not much higher than those that allow optimum growth of algae [51].

The value of copper (Cu) is 1.0 µg/L, according to Regulations Official Gazette, 5/2011.) 32/11, 48/15, 52/16, and 84/18) [20] due to Rulebook, is 0.05 mg/L. [21]. The value of the Cu in this research has a value of 0.004 mg/L (Table 3) and represents a smaller concentration compared to the one provided by Rulebook and Regulations (Table 9).

Investigations of concentrations of Cu in the water of Skadar Lake, in the amount of <0.001 mg were determined in the study Water Pollution of Skadar Lake, by CDM [1,52]. Low concentrations of eight (heavy) metals were determined in the water samples as approached in Table 9. All determined values of metal concentration are less in relation to the values of water quality criteria [21]). The concentration of all researched heavy metal in water are less than the limit established by the EU directive 75/440 EEC (European Environment Agency and EPA USA) [53].

Chemical and ecological status: PHS (priority hazardous substances) for evaluation of chemical status in water [20,21], was based on the concentration of the following metals: cadmium (Cd), mercury (Hg) and lead (Pb) priority substance (PS) in relation to MPC (Maximum Permissible Concentrations) for surface waters. Cd and Hg has lower values than the established MPC compared for surface waters and Pb has higher values compared to MPC for surface waters. Due to EQS (Environmental quality standards) within WFD, if one element has a higher value, then, therefore the chemical status cannot be described as: good, that is, it can be: bad or failing to achieve good. Based on the values of copper: 0.01 mg/L in relation to MPC + NC (natural concentration) (MPC+ NC= 0.073 + 0.01 mg/L), zinc: 0.004 mg/L (MPC + NC = 0.078 + 0.042 mg/L), chromium: 0.02 mg/L (MPC + NC = 0.160 mg/L) and arsenic: 0.01 (MPC + NC = 0.021 mg/L) which are within the EQS as specific pollutants (SP), are less than natural concentration, which indicates
good ecological status (although according to recommendations, if at least one parameter deviates from the MPC value, then the total status cannot be defined as good. That is why its characterized as prove to be good) [20,21,53].

4.2. Sediment-(Heavy) Metal Concentration

Generally, the aquatic sediments are the ultimate sink for metal pollutants. Geochemical elements in Lake sediments are influenced by anthropogenic processes. Over the past several decades, human activities have accelerated cycling of geochemical elements and resulted in elevated metal deliveries to water bodies. Sediment cores can provide chronologies of metal concentrations in sedimentary sequences and have been used to reveal human influences on heavy metal accumulation [54].

Canada and the Netherlands have a long tradition of legislation regarding sediment and are at the forefront of developing criteria and regulations on sediment quality and these toxicological guidelines were used for comparison with research data (Table 10).

Table 10. Comparison of research data with Canadian’s and Netherland’s sediment quality guidelines [24,25].

| Metals   | Unit | Research Data | Canada SQG | < or > | Netherland SQG | < or > |
|----------|------|---------------|------------|--------|----------------|--------|
| Lead     | mg/kg| 12.0          | 35.0       | <      | 85.0           | <      |
| Cadmium  | mg/kg| 0.26          | 0.6        | <      | 0.8            | <      |
| Copper   | mg/kg| 41            | 35.7       | >      | 36.0           | >      |
| Zinc     | mg/kg| 84            | 123        | <      | 140            | <      |
| Chromium | mg/kg| 111           | 37.3       | >      | 100            | >      |
| Mercury  | mg/kg| 0.08          | 0.17       | <      | 0.3            | <      |
| Arsenic  | mg/kg| 7             | 5.9        | >      | 29.0           | <      |

Chromium. The inputs of industrial wastes have changed the levels and forms of chromium in many lakes. Cr is one of the most common ubiquitous pollutants in the environment, does not occur naturally in the pure metallic form. Chromium contents in sediments represent permanent environmental and human health risks [55,56].

The highest concentration of all analysed metals in sediment of this location was determined for chromium, with the value of 111 mg/kg. The content of Cr, established by author Kastratovic et al [57] was in the range of 35.6–127 mg/kg dry weight; the value of 127 mg/kg is the highest determined concentration of analysed chromium in the sediment of Skadar Lake in the available literature. Author stated that the largest proportion of detected Cr (50.6%) was associated with the oxidizable phase in the form of organic complexes [57]. If we compare these researches with investigation of the Moraca river mouth (near the location of Vranjina), the highest determined value of chromium was in the amount of 57.8 mg/kg [40].

Comparing research data in this study, with sediment quality guidelines, it is observed that the Cr concentration is higher than the Canadian but lower than Netherland concentration value (Table 10).

Our hypothesis is that sources of chromium could be from the waste of the Aluminum Plant near Podgorica and Moraca River, because over a few decades. Aluminum Plant created about 325,000 m³ of solid waste, deposited and classified as a hazardous waste, because of the high content of fluorides, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phenols, nickel, chromium, copper, cadmium, zinc, arsenic, mercury, cyanide, mineral oils and other. In accordance to Dutch standards for hazardous and harmful substances in the soil, a value of 380.0 mg/kg is considered a high risk concentration (HRC), while the concentration of chromium in the waste disposal site (494.39 mg/kg) of the aluminium plant as well as concentration in the soil directly below the waste (404.88 mg/kg) exceeds that concentration [1].

Most of the zinc introduced into aquatic environments is eventually partitioned into the sediments and most is in a soluble form, bound to oxides of iron and manganese, carbonates and organic substances, while about 30% is insoluble. The proportion of zinc in the sediment depends mainly on the pH and the redox potential [50].
Regarding to the sediment quality guidelines (Netherland) targeting value is Zn = 140 and the Canadian, theoretically possible impact value, Zn = 123, ISQG (Sediment Quality Guidelines Canada) [23,24]. The values determined in this study 84 mg/kg Zn are much smaller. The concentration of Zn in Skadar Lake, in the range of 47.6–117 mg/kg (mean value, 75.4 mg/kg) was determined by Kastratovic and Jacimovic [50].

According to research of sediment from Albanian side of Skadar Lake, from few localities, Zn value variation is from 10.5 mg/kg to 69 mg/kg. Its average value was 35.4 mg/kg, which represents somewhat more approximate in relation to those in this study, which was established by author Bekteshi [58]. Author states that the value from Albanian side of Skadar Lake, it was fortified that the metals were present in the sediment in Skadar Lake, at higher values than those found in natural conditions, suggesting contamination with heavy metals from anthropological source, and zinc (Zn) concentration was found to be 72.14 ppm.

In relation to the Netherland’s (36.0 mg/kg) [25] and Canadian’s (35.7) [24] sediment quality safety guidelines, the values of coper determined in this study (41 mg/kg) were higher. In accordance with the concentration of the sediment analysis, copper is on the third position (Cr > Zn > Cu), less than the stated values by this research were determined by analysis of the sediment of the Moraca River mouth-established value were 17.4 mg/kg [40]. Author Duborija [59], states the amount of coper extracted from the sediments of Skadar Lake and its tributaries averaged to 19.5 mg/kg and the value of 8.92–33.7 mg/kg stated author Kastratovic [57]. The values of copper in sediment determined by research of this author are smaller in relation to the values established in this study. Sediment accumulates chemicals that can be toxic to biota and often contribute to the deterioration of the aquatic ecosystem [57,60].

Lead: In urban areas, the environment is polluted by the combustion products of leaded gasoline. In fact, the main sources of lead are industrial wastewater and transport, etc. [61,62]. In the aquatic environment lead is primary bound in sediment. The lead concentration established in this study was 12.0 mg/kg (Cr > Zn > Cu > Pb). If we compare it with the Canadian and Dutch sediment quality guidelines, the value is much lower (Table 10). Different values of lead Pb, in the sediment of Skadar Lake was determined, according to different researches in different time periods, has been established. The concentration of Pb, Cd, and Hg does not have to be very high, but are certainly toxic [63]. Chronological overview through several decades the following minimum and maximum concentrations (mg/kg), with mean values for the following years: 1993–1996: 12.4–30 (15.9 ± 6.3); 2005: 40.2–49.4 (45.6 ± 3.84); 2008: 13.6–35.1 (22.9 ± 7.74); 2010: 0.1–15.9 (11.7 ± 4.7); 2011: 16.6–46.2 (28.1 ± 9.88) was given by author Kastratovic [64]. Author Paliuolis [62] stated that analysed concentration of Pb in Sudotelis Lake bottom sediments weakly depends on the organic matter quantity (r = 0.077).

Arsenic: In accordance with the Canadian sediment (5.9) quality safety guidelines [24], values determined in this study, has higher value (7 mg/kg). Compared to Dutch regulation [23], target value of 29 mg/kg, with the quantity determined in this study has a much lower value. Author Kastratovic [64] states that As concentration varies from 2.5 to 7.0 mg/kg, i.e. 3.6 ± 2.2. This maximum determined value of As in sediment corresponds to the value in this study.

Barrett et al. [65] undertook an investigation of arsenic cycling in two impacted Lakes within the Puget Sound region, a shallow weakly stratified lake and a deep seasonally stratified lake, with similar levels of lakebed arsenic contamination. They found that the processes that cycle arsenic between sediments and the water column differed greatly in shallow and deep lakes. In the shallow lake, seasonal temperature increases at the lakebed surface, which resulted in high porewater arsenic concentrations that drove larger diffusive fluxes of arsenic across the sediment–water interface compared to the deep, stratified lake. As a result, strong arsenic mobilization from sediments in the shallow lake was countered by large arsenic sedimentation rates out of the water column driven by plankton settling [65].
Cadmium. The main sources of cadmium are industrial wastewater. Cadmium and its compounds are very toxic and although their toxicity has been established in the first half of the last century.

In this study, a relatively low concentration of cadmium in the sediment was found (0.26 mg/kg). It has been established much lower values than those determined by Datch (0.8 mg/kg) and Canadian (0.6 mg/kg) regulatory [23,24]. The concentration of cadmium (Cd) in the sediment of Moraca River mouth (tributary of Skadar Lake) with value of 0.6 mg/kg was established [40]. The total quantity of cadmium in the sediments of Skadar Lake with value of 0.27–0.66 (0.40 ± 0.13) was determined by author Kastratovic [66].

Cadmium in aquatic systems accumulates in sediments where it presents a risk to benthic biota and under certain conditions may reenter the water column; accumulate in aquatic biota with a long half-life [67].

Mercury concentrations in Lake and stream sediments vary by many factors pertaining to geology, atmospheric Hg deposition, climate, vegetation, topography, as well as soil and sediment composition [68]. Mercury is considered by WHO as one of the top ten chemicals or groups of chemicals of major public health concern.

In this research, the value of mercury of 0.08 mg/kg has been established. Compared with Dutch (0.3 mg/kg) and Canadian values (0.17 mg/kg) [23,24], lower values were determined. The concentration of mercury in the sediment of Moraca River mouth, with value 0.03 mg/kg was established [40]. Higher values of Hg concentration in sediments of Skadar Lake for 2016. was determined from 0.29 to 1.77 mg/kg [66] and 0.76 ± 0.52 mg/kg, in 2018 [64].

4.3. Aquatic Plants, Phytotoxic Effects; (Heavy) Metal Concentration in Stem, Leaf and Fruit (Trapa Natans), BCF, BSAF, TA and Short Review of Initial Research of the Water Chestnut (Skadar Lake)

Monitoring of sediment and biota can be used together with the water medium to provide a comprehensive review of the status of the water bodies. The heavy metal concentration in aquatic plants follows the heavy metal concentration in water, and sediment.

Phytotoxic effects of metals: From sediment and water, plants can accumulate metals that are essential for their growth and development, while there are plants that accumulate some heavy metals that do not biological role in their organisms. However, the accumulation of these metals in plants can be toxic.

It is undeniable that heavy metals cause phytotoxic effect -physiological weakening, although it has been established that some plants tolerate elevated concentrations of accumulated metals as well as accumulate them unusually high concentrations. However, as part of the elemental composition of Lake sediments, heavy metals are potentially toxic to ecosystems through the processes of bio-accumulation and bio-magnification [60,68].

Comparing data of metals concentration in the Trapa natans in relation to Codex Alimentarius, the following was established: a. stem values of Pb, Cd, Cu, Zn, Hg, and As are less (Table 3) than the values given in Codex Alimentarius, with the exception of Al which shows a higher value; b. leafs Pb, Cd. Hg and As (Table 3) have lower values and Cu, Zn, and Al have higher values compared to Codex Alimentarius; c. fruit, Pb, Cd, Hg, and As (Table 3) also have lower values and Cu, Zn, and Al have higher values compared to Codex Alimentarius [23]. In this research BCF (Table 6) in the stem, leaf and fruit has high values of: Al, Cr, Cu and Zn, while for the (Figure 5) biota sediment accumulation factor (BSAF), the highest values for the: Hg, Cd, Cu and Zn were determined. Kendall correlation coefficient between metals concentration stem–leaf (Figure 4a) is R = 0.87 (p = 0.016) represent significant positive coefficient, as well as the same between stem-fruit (Figure 4d). The highest degree of the determined Kendall correlation is observed between leaf and fruit R = 1 (p < 0.054) (Figure 4c).

There are a small number of studies on the metals concentration in aquatic macrophytes of Lake Skadar, and particularly insufficient data on their concentration in different parts of aquatic macrophytes and their seasonal variations [69].
Analysis of the aquatic plant *Trapa natans* as bioindicator of metal contamination, follows the next order, in the stem: Al > Zn > Cr > Cu > Pb = Hg = As = Cd; leaf: Al > Zn > Cu > Cr > As = Hg = Pb = Cd and fruit: Al > Zn > Cu > Cr > Pb = Cd = Hg = As (Table 3), with dominance of Al in stem, leaf, and fruit. The translocation ability (TA) of water chestnut in relation stem-leaf, as well as stem-fruit (Tables 7 and 8) has the same dominance of (heavy) metals (TA: Pb = Cd = Hg = As > Al > Cr > Zn > Cu).

Author Petrovic [70] analysing Cd, Pb and Cr in *Trapa natans* and determined that Cd in different parts of the plants varied between 0.03 and 1.05 mg kg$^{-1}$; Cr varied between 0.37 and 15.8 mg kg$^{-1}$. For Pb, concentrations were in the range from 0.03 to 3.68 mg kg$^{-1}$. Established value of Cd (BCF= 0.1–3.7) for Pb and Cr, demonstrated similar (BCF = 0.01–0.5 and 0.02–0.5, respectively) [70].

In this research the value of Cr are: 0.27 mg/kg in stem, 0.61 mg/kg in leafs and 0.30 mg/kg in fruit, while concentration of Cd and Pb in all three parts of plants has value of 0.01 mg/kg (Table 3); research of BCF (Table 6) in the stem, leaf, and fruit has high values of: Al, Cr, Cu and Zn, while for the (Figure 5) biota sediment accumulation factor (BSAF), the highest values for the: Hg, Cd, Cu and Zn were determined.

The bioaccumulation capacity of *Lemna minor* (aquatic macrophyte of Skadar Lake) followed descending order: Mn > Zn > Ni > Co > Pb > Cu > Cr > V > Sr > Cd. Author stated that difference in the order of the metal content in a plant compared to the sequence of their bioaccumulation ability shows the different bioaccumulation capacity of *Lemna minor* for certain metals, regardless of their concentration in the environment [69].

By analyzing the metals concentration in *Trapa natans* var *bispinosa* from the Lucknow Region, author founded a decreasing tendency in Pb. The maximum concentration of 16.40 Pb mg/kg dry weight was in leaf; the minimum Pb concentration of 5.40 mg/kg dry weight was found in kermel. Leaf > root > peel > stem > kernel. The concentration of Cu followed the same trend in all the treatments: root > leaf > stem > peel > kernel [71].

There are many contrasting views on the ecology of *Trapa natans*. 1753. and its importance in aquatic ecosystems. The term is used as a collective name for a complex of similar species of aquatic macrophytes that primarily differ in number and the size of the thorny (horn-like) growths on the fruit. Includes aquatic annuals herbaceous floating plants that most commonly inhabit stagnant or slow-flowing waters with marked fluctuations in water levels [71,72].

Initial research of the genus *Trapa* in the southeastern Balkans has done scientist Jankovic, M., who intensively investigated (from 1952 to 1991) the origin, distribution, systematics and ecology of the genus *Trapa*. Later, the scientist Blažencic, J. conducted research (1968–1973) on the anatomy and ecology of water chestnut. It is important to point out that the scientist Jankovic determined water chesnut from Skadar Lake as ssp: *Trapa longicarpa* ssp *scutarensis*. Since the mentioned scientific name does not yet listed in official system as well as in Plant List the common name *Trapa natans* was used in this article [72].

*Trapa* is on the Red List of Threatened Species in many European countries and is included in the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats), and it is protected as a tertiary relict of the Balkan Peninsula [72].

Many benefits of this plant are indisputable, such as its pharmaceutical significance as a healing herb, which is increasingly known and in use as herbal medicinal products. The only attention in the use of this aesculapian plant is how polluted aquatic ecosystem influences (in accordance with the aqueous plant bioavailability, bioconcentration and translocation) during use for healing purposes.

Natural systems are complex and it is common practice to isolate different factors to investigate the contribution of contaminants to ecosystem decline.

It is of great importance to determine the sources of pollution of Skadar Lake in order to maintain a healthy ecosystem and adequate application of the postulates of sustainable development.
4.4. Protection of Skadar Lake of National and International Importance with Sustainable Development Goals (SDGs)

As a result of the Lake’s natural richness, most of the Lake and its adjacent wetland areas are today under official nature conservation and are also recognized as wetlands of international importance under the Ramsar convention. The place on the Ramsar list of wetlands of international importance was obtained on the basis of the importance of habitats for ornithofauna, as well as on the basis of its overall diversity, especially as a habitat for water birds (criterion 3c). It has also been recognized as an area important for plants (Important Plant Area—IPA) since 2009. The boundaries of the IBA (Important Bird Area) and IPA site coincide with the boundaries of the Skadar Lake National Park. For the IPA area, the Lake is protected on the basis of criteria A (internationally and nationally significant species) and C (internationally significant habitats—habitats from the Habitat Directive). This IPA site is the habitat of the largest population of *Trapa natans* in Montenegro, and contains three types of aquatic and six types of terrestrial habitats.

Skadar Lake is recognized as a cross-border protected area (MNE and AL). Its wider surroundings as a cross border development zone (Spatial Plan of Montenegro from 2008). The Standing Committee of the Bern Convention nominated Skadar Lake on December 2, 2011, as an EMERALD area. The legal basis on which the establishment of the Emerald network is based are Resolutions 4 and 6 adopted by the Standing Committee of the Berne Convention. Resolution no. 4 (1996), identifies endangered habitat areas in Europe that require special conservation measures. Resolution no. 6 (1998) list 927, identifies those European species that require conservation measures for their habitats (so-called Emerald species). The Emerald network consists of areas important for the conservation of habitat types from Resolution 4 and species from Resolution 6 of the Berne Convention [5,6,73–77].

The zoning of the protected area is one of the basic steps in planning the use and management of space, the implementation of which should ensure the preservation of the natural values of the area. The zoning procedure of protected areas defines the existing planning and the plans for future use in accordance with the objectives of preserving the integrity of the nature. Zoning is based on the definition of protection zones, ranging from the degree where almost no anthropogenic impact is allowed (strict reserve), to the use zone where the natural space within the zone can be changed to some extent (III degree of protection). The degree of protection of an individual area is determined in accordance with the needs of preservation and management of natural values that characterize the protected natural asset and thus classify it in one of the pre-defined categories of protection.

Pursuant to the Law on Nature Protection, the division and types of protected areas are defined as well as several categories of protected areas, all according to their quality, type and regime of behavior permitted in them, which fully correspond to the IUCN (International Union for Conservation of Nature) categorization of protected areas. Zoning is a very complex process, because in practice it is very difficult to delimit, and even more difficult to limit certain activities, in order to avoid their negative impact, especially in zones with a strict protection regime. In accordance with the Law on Nature Protection, nature reserves have been established in the area of the National Park, three zones (I, II, and III), with different levels of protection and clearly defined restrictions, as well as a buffer zone [5,6,73–77].

Based on clauses 21 and 31, paragraph 1 of the Law on Spatial Planning and Construction of Facilities, the Government of Montenegro at its session (2014), passed a Decision on the development of the Spatial Plan of the special purpose of the National park Skadar Lake, an integral part of which is the Program task on the basis of which the SPOSP (Spatial Plan of Special Purpose) was established. According to the Decision and the Program task, the time horizon of the plan is 2025. The protection zone includes parts of the spatial units that gravitate to Skadar Lake, with a number of settlements in which sustainable development will take place in accordance with the adopted spatial planning framework. If the criterion of ecological sustainability is accepted as one the goals of development policy,
then the success of the measures is reflected in the avoidance of situations that threaten the balance between and within ecosystems [5,6,73–77].

The National Strategy for Sustainable Development of Montenegro, visions and sets general goals, as well as the main priority tasks leading to the pillars of sustainability:
- Preventing the degradation of renewable natural resources (biodiversity, water, air, land);
- Enabling efficient management of renewable natural resources;
- Improving the status of the environment and human health;
- Sustainable spatial planning;
- Efficient use of metallic and nonmetallic raw materials.

Based on trans-boundary diagnostic analysis and other work to date, it is expected that the SAP (Strategic Action Plan) will focus particularly on the following general objectives (with an emphasis on facilitating trans-boundary cooperation in all cases).

The Anticipated elements of the SAP are:
- Reduction and prevention of pollution of the lake water;
- Improved monitoring of biodiversity;
- Strengthening the management of natural resources, including promoting environmentally sustainable economic use of biological resources, as well as improved management of the protected areas;
- Promotion of environmentally sustainable tourism development with an emphasis on local community participation and potential benefits;
- Strengthening the legal and institutional framework for environmental protection, sustainable management and trans-boundary cooperation and exchange;
- Trans-boundary equality of the protected area, satisfying both high environmental standards and ensuring the sustainability of the activities developed;
- Strengthening the management of natural resources, including promoting environmentally sustainable economic use of biological resources, as well as improved management of the Protected Areas;
- Promotion of environmentally sustainable tourism development with an emphasis on local community participation and potential benefits;
- Strengthening the legal and institutional framework for environmental protection, sustainable management and trans-boundary cooperation and exchange;
- The trans-boundary equality of the protected area, satisfying both high environmental standards and ensuring the sustainability of the activities developed [78–81].

5. Conclusions

From the research carried out of the water and sediment of Skadar Lake, sampled near the settlement of Vranjina (a fishing village), as well as with an analysis of the bio-concentration factor (BCF) assessment, biota sediment accumulation factor (BSAF) and the translocation ability (TA) of the aquatic macrophyte, *Trapa natans* (water chestnut), as an indicator of water quality, the following conclusions can be drawn:

In accordance with the presence of increased concentrations of (heavy) metals, related to potential toxicity, the following (heavy) metals in the sediment have been established for: Cr (111 mg/kg), Zn (84 mg/kg), Cu (41 mg/kg), and Pb (12 mg/kg). The dominant metals concentrations in the water of Skadar Lake are: As > Pb > Zn.

The determined chemical status based on PS and PHS is bad (falling to achieve good), while established ecological status based on SP proved to be good.

The highest levels of all analysed metals in the water chestnut (*Trapa natans*), has been established for Al in the leaves (89.43 mg/kg), then in the fruits (28.53 mg/kg) and in the stem (26.6 mg/kg). A significant high positive correlation has been established between leaf and fruit (R = 1, p < 0.05).

The level of metal concentration in the stem decreases in the following sequential order: Al > Zn > Cr > Cu > Pb = Hg = As = Cd; in the leaves: Al > Zn > Cu > Pb = Cd = Hg = As; in the fruits: Al > Zn > Cu > Cr > Pb = Cd = Hg = As. The BCF
in the stem, leaf, and fruit has high values, mainly of Al, Cr, Cu, and Zn, while for the biota sediment accumulation factor (BSAF), the highest values were determined for the following elements: Hg, Cd, Cu and Zn.

The translocation ability (TA) of Trapa natans, between stem-leaf, for: Pb, Cd, Hg and As has a value of 1.0, and the fifth metal chromium (Cr) has a value of 0.443 (TA: Pb = Cd = Hg = As > Cr > Zn > Al > Cu). The translocation ability (TA) between stem-fruit has the same metal dominance, with an additional fifth metal, Al, with a value of 0.932 (TA: Pb = Cd = Hg = As > Al > Cr > Zn > Cu).

Based on the research, it can be concluded that the current situation in the part of Skadar Lake near the settlement of Vranjina (a fishing village) shows evident pollution, which is shown through the bio-concentration of metals in the aquatic macrophyte Trapa natans (water chestnut), while through translocation ability (TA) readings are shown indicating that in some parts of the plant, metals with particularly increased concentrations of Pb, Cd, Hg, and As have been retained.

The water chestnut (Trapa natans) samples were taken from a potentially polluted location and used for the monitoring of metals, as well as for analyses of water quality, where, based on the results of the research, a more comprehensive solution may still be reached for greater protection and eventual revitalization.

Recognizing the indisputable natural potential and the exceptional natural value of this area, and in order to adequately valorize and manage the subject area, it is essential to ensure the conditions required for more efficient ecological sustainability.

Funding: The funds has been co-financed by the Ministry of Science of Montenegro, through an official competition (Competition of the Ministry of Montenegro for co-financing of scientific research and innovative activities).

Institutional Review Board Statement: Not applicable for studies not involving human or animals.

Informed Consent Statement: Not applicable for studies not involving human.

Data Availability Statement: All data generated or analyzed during this study are included in this published article.

Acknowledgments: I would like to state sincere gratitude to the Ministry of Science of Montenegro.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Sundic, D.; Radujkovic, B. Pollution of the Skadar Lake; NGO Green Home: Podgorica, Montenegro, 2012; pp. 1–94.
2. Ministry of Sustainable Development and Tourism, Montenegro. Development of a commercial project in Skadar Lake National Park and candidate Emerald site (Montenegro)—Report by the Government. In Proceedings of the Standing Committee 40th Meeting, Strasbourg, France, 30 November–4 December 2020; Council of Europe: Strasbourg, France, 2020.
3. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ): Shorozone Functionality, Skadar/Shkodra Lake, Implementing the EU Water Framework Directive in South Eastern Europe. Available online: https://rm.coe.int/complaints-on-stand-by-development-of-a-commercial-project-in-skadar-1/168077e58c (accessed on 1 March 2021).
4. Dizdari, A.; Kopliku, D. Toxicity Bio-Monitoring of Shkodra Lake Surface Water Using a Higher Plant Assay. Acad. J. Interdiscip. Stud. 2013, 2, 133.
5. Ministry of Sustainable Development and Tourism of Montenegro. Spatial Plan of Special Purpose of the National Park Skadar Lake; Ministry of Sustainable Development and Tourism of Montenegro: Podgorica, Montenegro, 2018.
6. Ministry of Sustainable Development and Tourism. National Biodiversity Strategy with the Action Plan for the Period 2016–2020; Ministry of Sustainable Development and Tourism: Podgorica, Montenegro, 2015; pp. 1–82.
7. Keukelaar, F.; Goffau, A.; Pradhan, T.; Sutmuller, G.; Misurovic, A.; Ivanovic, S.; Uskokovic, B.; Agron, H.A.; Haxhimihali, E.; Prifti, A.; et al. Lake Shkoder Transboundary Diagnostics Analysis; Final Report: Summary No 9P6515.World Bank (IBRD) 9P6515; Royal Haskoning: Nijmegen, The Netherlands, 2006; pp. 1–18.
8. Keukelaar, F. The last 500 year of sedimentation in Shkodra Lake (Albania, Montenegro): Paleoenvironmental evolution and potential for paleoecosystemics studies. J. Paleolimnol. 2008, 40, 619–633.
9. Karmaka, S.; Mavukkandy, M. Lakes and Reservoir: Pollution, Chapter; Taylor & Francis: London, UK, 2013; pp. 1576–1587.
10. Shalabh, B.; Akash, J.; Chaudhar, J. Trapa natans (water chesnut) an overview. Int. Res. J. Pharm. 2013, 3, 31–33.
11. Bharthi, V.; Kavya, B.; Shantha, T.R.; Prathapa, R.M.; Kavya, N.; Rao, V.; Kalpeshkumar, B.I.; Venkateshwarlu, G. Pharmacognostical evaluation and phytochemical studies on Ayurvedic nutritional fruits of *Trapa natans* L. *Int. J. Herb. Med.* 2015, 3, 1–13.

12. Kang, W.; Li, Y.; Gu, X.; Huang, X. Hepatoprotective activity of *Trapa acornis* shell extracts against CCl4-induced liver injury in rats. *Acad. J. Pharm. Pharmacol.* 2012, 6, 2856–2861. [CrossRef]

13. Razvy, M.A.; Faruk, M.O.; Hoque, M.A. Environment friendly antibacterial activity of water chestnut fruits. *J. Biodivers. Environ. Sci.* 2011, 1, 26–34.

14. Stoicescu, I.; Sirbu, R.; Pirjol, T.N.; Cobia, M.; Balaban, D.P.; Camelia, B. In vitro antioxidiant and antibacterial activity of *Trapa natans* aquatic plant from Danube delta area. *J. Acad. Romana* 2012, 57, 729–733.

15. Shukla, A.D.; Gujrati, A.; Srivavasta, N. In vitro analysis of anti-bacterial activity of *Trapa natans*. *Int. J. Pharm. Res. Dev.* 2012, 3, 502–508.

16. Mandal, S.M.; Migliolo, L.; Franco, O.L.; Ghosh, A.K. Identification of an antifungal peptide from *Trapa natans* fruits with inhibitory effects on *Candida tropicalis* biofilm formation. *J. Elsevier Pept.* 2011, 32, 1741–1747. [CrossRef] [PubMed]

17. Ozturk, M.; Oozozen, G.; Minareci, O. Determination of heavy metals, in fish, water and sediments of Avsar dam Iran Lake in Turkey. *J. Environ Health Sci. Eng.* 2009, 6, 73–80.

18. Ali, H.; Khan, E.I. Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity and Bioaccumulation. *Environ. Chem.* 2019, 6730305. Available online: http://www.hindawi.com/journals/jchem/2019/6730305/ (accessed on 15 March 2021).

19. Garcia, M.E.; Bundschuh, J.; Ramos, O.; Quintanilla, J.; Persson, K.M.; Bengtsson, L.; Berndtsson, R. Heavy metals in aquatic plants and their relationship to concentration in surface water, groundwater and sediments, a case study of Poopo Basin. *Rev. Boliv. Quimica* 2005, 22, 11–18.

20. Ministry of Agriculture and Rural Development, Ministry of Health and the Ministry of Sustainable Development and Tourism. *Regulation for Determining the Status of Surface Waters*; Ministry of Agriculture and Rural Development, Ministry of Health and the Ministry of Sustainable Development and Tourism: Podgorica, Montenegro, 2019; pp. 1–39.

21. Government of the Republic of Montenegro: Rulebook on Classification and Categorization of Surface and Ground Water. Available online: https://www.morskodobro.com/dokumenti/uredba_klasifikacija_kategorizacija_podzemnih_voda.pdf (accessed on 1 March 2021). (In Montenegrin)

22. The Food and Agriculture Organization (FAO): Working Document for Information and Use in Discussions Related to Contaminants and Toxins in the GSCTFF. Available online: http://www.fao.org/tempref/codex/Meetings/CCCF/CCCF5/cf05_INF.pdf (accessed on 1 March 2021).

23. Directorate for Foodsafety, Veterinary and Phytosanitary Affairs: Regulation on Maximum Permitted Levels of Contaminants in Food. Available online: https://ubh.gov.me/biblioteka/sektor_1/uredbe/?query=hrani&sortDirection=desc (accessed on 1 March 2021). (In Montenegrin)

24. Canadian Council of Ministries of the Environment: Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Available online: https://www.ccme.ca/en/res/mercury-canadian-sediment-quality-guidelines-for-the-protection-of-aquatic-life-en.pdf (accessed on 1 March 2021).

25. The Netherlands Ministry of Housing, Spatial Planning and Environment; Circular on target values and intervention values for soil remediation. Available online: https://www.esdat.net/environmental%20standards/dutch/annexs_i2000dutch%20standards%20public%20environmentalstandards.pdf (accessed on 1 March 2021).

26. Mackay, D.; Fraser, A. Biaccumulation of persistent organic chemicals, mechanisms and models. *Environ. Pollut.* 2000, 110, 375–391. [CrossRef]

27. McGeer, J.; Brix, K.; Skeaff, J.; DeForest, D.; Brigham, S.; Adams, W.; Green, A. Inverse Relationship Between Bioconcentration Factor and Exposure Concentration for Metals: Implications for Hazard Assessment of Metals in the Aquatic Environment. *Environ. Toxicol. Chem.* 2003, 22, 1017–1037. [CrossRef]

28. Pollman, C.D.; Axelrad, D.M. Mercury bioaccumulation factors and spurious correlations. *Sci. Total Environ.* 2014, 496, 6–12. [CrossRef]

29. Niteda, L.A.; Manohar, S. Bioconcentration factor and translocation ability of heavy metals within different habitats of hydrophytes in Nairobi Dam, Kenya. *J. Environ. Sci. Toxicol. Food Technol.* 2014, 8, 42–45.

30. Nyatwere, L.M.; Diakun, J.C. The Potential of Bioaccumulation and Translocation of heavy metals in plant species growing around the Tailing Dam in Tanzania. *Int. J. Sci. Technol.* 2014, 3, 690–697.

31. McDonald, M.J. *Handbook of Biological Statistic*, 3rd ed.; University of Delaware: Baltimore, MD, USA, 2014; pp. 1–299.

32. Bolboacai, S.D.; Jintschi, L. Pearson versus Spearman, Kendall’s Tau Correlation Analysis on Structure Activity Relationships of Biologic Active Compounds. *Leonardo J. Sci.* 2006, 9, 179–200.

33. ATSDR. Priority List of Hazardous Substances. Agency for Toxic Substances and Diseases Registry. 2007. Available online: http://www.atsdr.cdc.gov/ (accessed on 28 July 2009).

34. ATSDR CERCLA. Priority List of Hazardous Substances. ATSDR Home. 2007. Available online: http://www.atsdr.cdc.gov/cercla/07list.html (accessed on 22 March 2011).

35. U.S. Environmental Protection Agency (EPA). *Locating and Estimating Air Emissions from Sources of Arsenic and Arsenic Compounds*; Environmental Protection Agency (EPA): Washington, DC, USA, 1998; pp. 1–82.
65. Barrett, P.M.; Hull, E.A.; Burkart, K.; Hargrave, O.; McLean, J.; Taylor, V.F.; Jackson, B.P.; Gawel, J.E.; Neumann, R.B. Contrasting arsenic cycling in strongly and weakly stratified contaminated lakes: Evidence for temperature control on sediment–water arsenic fluxes. *Limnoogy Oceanogr.* 2019, 64, 1333–1346. [CrossRef]

66. Kastratovic, V.; Jacimovic, Z.; Bigovic, M.; Djurovic, D.; Krivokapic, S. Environmental status and geochemical assessment sediments of Lake Skadar, Montenegro. *Environ. Monit. Assess.* 2016, 188, 1–15. [CrossRef]

67. Genchi, G.; Sinicropi, M.S.; Lauria, G.; Carocci, A.; Catalano, A. The effects of cadmium toxicity. *Int. J. Environ. Res. Public Health* 2020, 17, 3782. [CrossRef]

68. Patra, M. Sharma, A. Mercury Toxicity in Plants. *Bot. Rev.* 2000, 66, 379–422. [CrossRef]

69. Kastratovic, V; Jacimovic, Z.; Djurovic, D.; Bigovic, M.; Krivokapic, S. *Lemna minor* L. as bioindicator of heavy metal pollution in Skadar Lake (Montenegro). *J. Sci.* 2015, 37, 123–134. [CrossRef]

70. Petrovic, D.; Jancic, D.; Furdek, M.; Mikac, N.; Krivokapic, S. Aquatic Plant *Trapa natans* L. as Bioindicator of Trace Metal Contamination in a Freshwater Lake (Skadar Lake, Montenegro). *Afr. J. Agric. Res.* 2013, 8, 2765–2768.

71. Markovic, G.; Vicentijevic-Markovic, G.S.; Tanaskovic, S.T. First Record of Water Chestnut (*Trapa natans* L. Trapaceae, Myrtales) in Central Serbia. *J. Cent. Eur. Agric.* 2015, 16, 436–444. [CrossRef]

72. Ministry of Tourism and Environment of Montenegro, Ministry of Environment, Forests and Water Administration of Albania (MEFWA). Lake Skadar Shkodra Integrated Ecosystem Management Project. The Strategic Action Plan (SAP) for Skadar Shkodra Lake Albania & Montenegro. Available online: https://iwlearn.net/resolveuid/b8fab0fe-f54b-4113-814e-850a52eefc04 (accessed on 1 March 2021).

73. Ministry of Sustainable Development and Tourism. *Strategic Environmental Impact Assessment Report for Spatial Plan of Special Purpose of Skadar Lake National Park*; Ministry of Sustainable Development and Tourism: Podgorica, Montenegro, 2018; pp. 1–98.

74. Ministry of Sustainable Development and Tourism. *Strategic Environmental Impact Assessment Report for Spatial Plan of Special Purpose of Skadar Lake National Park*; Ministry of Sustainable Development and Tourism: Podgorica, Montenegro, 2018; pp. 1–98.

75. Bejko, D. Promoting Environmental Protection through the Management of Shared Natural Resources between Albania and Montenegro: The Shkodra Lake Watershed. In *Environmental Security in South-Eastern Europe*; Montini, M., Bogdanovic, S., Eds.; Springer: Dordrecht, The Netherlands; Berlin/Heidelberg, Germany, 2011; pp. 197–212.

76. Dhora, D.; Sokoli, F.; Ligeni, S. *Lijeni i Shkodrës—Biodiversiteti*; UNDP, GEF/SGP, SHRMMNSH: Shkoder, Albania, 2000; pp. 14–23. (In Albanian)

77. Keukelaar, F.; Goffau, A.; Pradhan, T.; Sutmuller, G.; Misurovic, A.; Ivanovic, S.; Uskokovic, B.; Hetoja, A.; Haxhimihali, E.; Prifti, A.; et al. Lake Shkoder Transboundary Diagnostic Analysis, Albania and Montenegro. Available online: https://www.ais.unwater.org/ais/aiscm/getprojectdoc.php?docid=1445 (accessed on 1 March 2021).

78. Strbac, N.; Vukovic, M.; Voza, D.; Sockic, M. Sustainable Development and Environmental Protection. *Recycl. Sustain. Dev.* 2012, 5, 18–29.

79. United Nations: The Sustainable Development Goals Report. Available online: https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf (accessed on 1 March 2021).

80. *National Strategy of Development in Montenegro*; Government of Montenegro, Ministry of Sustainable Development and Tourism: Podgorica, Montenegro, 2007; pp. 1–125.

81. Ministry of Ecology, Spatial Planning and Urbanism, Government of Montenegro: Nacionalna Strategija Održivog Razvoja do 2030. godine. Available online: https://mrt.gov.me/biblioteka/strategije?AccessibilityFontSize=default (accessed on 20 March 2021). (In Montenegrin)