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Risk assessment of Butrinti lagoon: spatial and temporal distribution of heavy metals in different pools

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Abstract

Heavy metals enter in lagoons from pedo-geological background as well as from man-made sources through several pathways. Heavy metals released into the water are eventually accumulated in the sediments and in the lagoon's aquatic organisms, especially in mussels, which act as recorders of heavy metals pollution event. This study aims to contribute in (i) quantifying the origin and degree of heavy metals pollution in the sediments, water lagoon and mussels, (ii) exploring the concentrations of heavy metals in mussels widely cultivated in this Lagoon. The water samples were taken at the surface and bottom of the lake between May 2010 and January 2011. The results showed that the concentrations of Cd (2.9 mg kg^{-1}) were higher in soils formed over lime in the north of the Lagoon. Hg was nearly 234.89 µg kg^{-1}, which is also considered of medium values for these types of soil. The maximum values of Cr content were 237.38 mg kg^{-1}, or much higher than the average of soils over lime in Albania. The highest concentrations in sediment samples (mg kg^{-1}) for Pb (346), Cd (4.14), Cr (171.9) and Hg (36.4) were found in the eastern and southern area of the Lagoon where there have been intensive agricultural activities. The results showed that the concentration (µg L^{-1}) of Pb (10.78) at the lake bottom in May was higher than at the surface of water but it was generally low when compared to the WHO standard. On the other hand Cr was high with mean values of 56.6 µg L^{-1} at the bottom of the lake water in August. The data also indicated that mussels'samples which was collected in May in the southern area of the Lagoon showed higher levels (mg kg^{-1}) of Pb (0.49) and Hg (0.14). However, the highest concentrations of Cd (0.36), Cr (0.50) were recorded in August. There is a correlation between the heavy metals and their sources. We hold that some precautions should be taken against the heavy metal pollution around Butrinti Lake considering the ecological, agricultural and economic importance of this area.

Keywords: Heavy metals, pollution, Butrinti Lagoon, mussels.

1. Introduction

Butrinti lagoon (16 km^2) is one of the most interesting lagoons of tectonic origin. It is connected to Bufi Lake by a communicating channel of a flow of 3 m^{3}sec^{-1}, and also to the Ionian Sea by a 3 km long canal. During the past few decades, the lagoon has been used intensively in the aquaculture of mussels (*Mytilus galloprovincialis*) (up 4500 ton gross product/year-2009 and still 85 000 tons - 1988) [1] The main anthropogenic pressure in Butrinti lagoon is represented by agricultural activities, tourism and urban development, while mussel farming represents one of the main economic activities in the region. Heavy metals enter into the Lagoon environment from natural as well as man-made sources through several pathways, e.g. weathering processes reaching aquifers mainly through subterranean waters and runoff, atmospheric depositions, point as well as non point pollution sources. Heavy metals released into the water eventually accumulate in the sediments, which act as recorders of heavy metal pollution event [2, 3]. Although heavy metals enter in the Mediterranean Sea from natural sources, e.g. pedo-geochemical background [4], industrialization and human activities ha have caused an increase in the emission of heavy metals into the marine environment in the last decades resulting in polluted hot spots near urbanized coastal and transitional water areas [5, 6]. The main land-based pollution sources are in the Albanian coastal area, including lagoons, urban, agricultural and industrial effluents [3]. The assessment of heavy metals is directly related to the food chain as the primary product in the Lagoon are the mussels which are fixed on a lot of installations (73) and have a productivity of 4500 tons a year. The passing of heavy metals form sediment to mussels becomes evident in conditions of high temperatures that cause high mineralization coefficients. The aim of the present work was to contribute in quantifying the temporal, spatial distribution of the heavy metals and the degree of heavy metal, and explore the role of heavy metals

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spatial distribution of the heavy metals and the degree of heavy metal, and explore the role of heavy metals in the safety of the food chain. The influence of the watershed on heavy metals concentration in sediment, water and mussels was examined.

2. Materials and Methods

Soil, water, sediment and mussels samples were collected to meet the need for an assessment risk. This sampling was carried out for four consecutive times in May-2010, August-2010, and November-2010 and in January-2011. Sampling points were counted as follows: Point 1 (N: 39^0 48 '556"and E: 20^0 01'808") was set 100 m away from Bistrica River, on the lake to see its impact as pure and sweet water with volume about 5 m3/sek in the ecosystem of the lake; Point 2 (N: 39^0 47 '540' and E: 20^0 02'885") was appointed in front of Cimikos hill and near the river gorge flow of Pavel River; Point 3 (N: 39^0 46’ 880’’and E: 20^0 02'723’’) was determined in front of a small valley between two low and soft hills, which served for grazing; Point 4 (N: 39^0 45’ 370’’ and E: 20^0 02'788’’) was appointed as the place where Butrint Lake and Bufi lake are connected; Point 5 (N: 39^0 45’ 311’’ and E: 20^0 02'175’’), the southern part of the lagoon; Point 6 (N: 39^0 46’ 695’’ and E: 20^0 01'054’’) Pallavraq; Point 7 (N: 39^0 48’ 332’’ and E: 20^0 01'240’’) near the location of the mussel factory.

The water samples were taken at the surface and bottom of the lake (50 cm under the surface and 50 cm over the Lagoon bed). The soil samples were taken in three different locations : in the field of Vurgu (1000 m above the northern part of the Lake) (samples 1/1, 1/2 and 1/3), in the area where river Pavlo flows (water channel), in Cuke- Pllake road (samples 2/1, 2/2 and 2/3) and Bufi hills (sample 3/1, 3/2 and 3/3), to see the potential impact of agriculture in Lakes Bufi and Butrinti. The sediment samples were taken at the same sampling stations of water and mussels.

2.1 Heavy metals analysis

In order to extract the heavy metals in mussels there was used a 0.25 g sample of meat that is placed in a container to which we added 4ml HNO_3 and 1 ml H_2O_2. Samples were mineralized with a microwave digester, than the dissolved sample is transferred in a 100 ml balloon, where it was adjusted to distilled water with 2% HNO_3. The concentrations of heavy metals were determined by Graphite Furnace AAS. The concentrations of Hg were determined by VGA77 (Cold vapors Apparatus).

In order to determine the heavy metals in the lagoon water (Cd, Cr, Cu, Pb, Hg) the AOAC Official Method 974.27 [7] was used. Metals in solution are determined directly by AA spectrophotometer. Hg is measured in AA spectrophotometer using AOAC Official Method 977.22 [8].

To determine the total heavy metals concentration in soils and sediments a closed vessel microwave-assisted digestion system under high temperature and pressure [9, 10] was used. The dried samples were then ground into fine powder, sieved with <2 mm and 2.5 mL of conc. HNO3 and 2.5 mL of HF acid were added. Reaction vessel was then inserted into a carousel and into the microwave unit ready for digestion. Afterwards, the digested solution was cooled and filtered using Whatman filter paper No. 40. The filtered sample was then made up to 100 mL with metal-free distilled water and stored in a special container ready for analysis. The concentration of heavy metals in the extracts was determined by Graphite Furnace AAS.

To determine the fraction of metal in solution, we carried water extraction. Thus, 5 g soil sample was placed in suspension 50 ml distilled water. The Mixed soil solution was shaken for 20 hours in order to reach the equilibrium stationary, and it was left to rest for several hours so that solid particles would deposited on the bottom. The liquid was filtered with a membrane with 0.22µm. The concentration of heavy metals in the extracts was determined through the use of Graphite Furnace AAS. DTPA-extractable metals were chosen as an estimate of soil Ni chemical metal availability. Although it only reflects the potential pool of available metals, it allows for a relative comparison of soils. Heavy metals availability in different soil samples was characterised by DTPA - TEA. DTPA-extractable heavy metals were determined using the method of Lindsay and Norvell 1978 [11]. The concentration of metals in soil extracts was determined by Graphite Furnace AAS.

3. Results and Discussion

3.1Heavy metals in the soil

Pb in soil varied from 8.3 to 37.3 mg Pb kg^{-1} soil and the average value was 16.95 mg Pb kg^{-1} soil, which is relatively a normal value. The highest value was found at point1 inVurgu field and Bufi hills. This high value is possibly a consequence of agricultural inputs. The culture history is dominated by fruit trees and grapevine, for which high quantities of fertilizers and other inputs are used. Cd was on average 0.58 mg kg^{-1}, a normal value for Eutric Cambisol soils (Bufi soils).

Hg was nearly 234.89 µg kg^{-1}, which is also considered a medium value for these soil types. The value of Cr was nearly 117.34 mg kg^{-1} and the maximum value was about 237.38 mg kg^{-1}, or much higher than the average of soils in Albania (150 mg Cr kg^{-1},[12]). The mean value of Cu was 54.39 with higher value 82.24 mg kg^{-1} at SS1/2, and the minimal value at SS3/1. Generally, the highest values of heavy metals are found in the Vurgu plain with high values of organic matter due to the origin. Based on the methodology of risk assessment, it was necessary to compare the values of heavy metals found in the soils around the Lagoon with those in the sediment. In order to assess the displacement of cationic forms of metals from the upper stream to downstream and to realize the connection between the huge quantities in soil and sediment, we did the extraction of metal in distilled water which enables the quantification of released forms, chemically unbound to the minerals and/or the clay/organic compounds, and with DTPA (diethylentriaminepentaacetic acid) to explore the metals bioavailability in the soil.

Table 1. Heavy metals in the soil sampling: sampling in the North (1-2) and North-East (3)

No.	*Samples*	*mg kg^{-1} soil*				*Hg µg kg^{-1} soil*
		Pb	Cd	Cr	Cu	
1	**SS1/1 - Soil: 0-30 cm Wheat**	37.30	2.9	237.38	73.27	234
2	**SS1/2 - Soil: 0-30 cm, Maize**	11.78	0.658	90.74	82.24	236
3	**SS1/3 - Soil: 0-30 cm, Maize**	9.380	0.221	157.69	72.30	319
4	**SS2/1 – Soil: 0-30 cm, Maize**	14.51	0.220	143.43	42.02	210
5	**SS2/2 – Soil: 0-30 cm, Forage**	8.337	0.221	144.61	32.30	218
6	**SS2/3 - Soil: 0-30 cm, Maize**	14.31	0.259	130.96	43.46	207
7	**SS3/1 – Soil: 0-30 cm citrus**	11.87	0.236	51.067	25.82	214
8	**SS3/2 – Soil: 0-30 cm , Viticulture**	19.54	0.263	53.45	75.70	258
9	**SS3/3 – Soil: 0-30 cm, Olive trees**	25.55	0.271	46.73	42.37	218
Average		*16.95*	*0.58*	*117.34*	*54.39*	*234.89*
Standard Deviation		*9.30*	*0.88*	*63.06*	*21.30*	*35.38*

Water extraction is a routine practice in soil studies because it is too close to the natural conditions, especially in the Mediterranean area where the rain storms in autumn-spring create a saturation with water over the soil surface and this affects the release of cation chemically unbound to clay. The mobility of metals from the soil is determined by the origin of the element [13], and the different physico-chemical reactions of the soil [14]. The mobility is characterized by the ability of elements to move from a pool of soil to another [15]. So the amount of Cu extracted with water in Butrint soils is relatively high ranging from 0.2 to 0.56 mg Cu kg^{-1}. The concentration of Cr and Pb extracted with water in Butrinti soils ranged respectively 0.03-0.084, 0.01-0.1. So the amount of metals extracted with water (metals in soil solution) in Butrinti soils is relatively high due to this fact: Cu> Cr> Pb. These elements are potentially possible to leachate from the soil. The higher concentration of Cu extracted with water can be explained by the fact that copper compounds are used as or in fungicides, insecticides and fertilizers. The values of heavy metals extracted with DTPA are higher for Cu, Pb and lower for Cd and Cr. So the DTPA Cu was higher (31 mg Cu kg^{-1}) in SS2/3 and lower (3 mg Cu kg^{-1}) in SS2/1, where the soil is not treated with pesticide and fertilizer for some years. Also the Pb DTPA extractable was higher (0.534 mg Pb kg^{-1}) in SS2/3, but the higher (1.9 mg Pb kg^{-1}) value was in SS3/3 where the agriculture activity was higher. The concentration of Cd extracted with DTPA ranged 0.07-0.3 with the higher values in SS2/3 like Cu and Pb. The metals extracted with DTPA, represent ions weakly absorbed by solid phase that are potentially available to pass into solution, and especially to take up by living organisms.

3.2 Heavy metals in the sediment

The samples were taken for sediments in the same sampling stations as for water and mussels in the summer season. The results of samplings presented in the table below show that Pb is found in huge quantities; the values range from 14.91 (SS1) to 346 mg Pb kg^{-1} sediment (SS4). The mean value was 144.58 mg Pb kg^{-1} sediment and was higher than the average values found at the Lagoons of Agiasma, Thiu and Messolongi in Greece [16] and lower than those of Venice Lagoon, where there is an intensive naval activity. The highest quantities of Pb are found at SS4, SS6 and SS3, which are situated in the eastern and southern area of the Lagoon and near the communicating channel between Bufi Lake and the Lagoon. Based on the preliminary data, it results that the quality of water and especially of sediments derived from the east part affects the quality of the sediment of the Lagoon. The lowest values in stations 1 and 2 are influenced by the fresh water of Bistrica and Pavlo rivers and lower slope of the plain. The Pb content in the sediment is on average 8 times higher than its content in the surrounding soils.

Table 2. Heavy metals in sediments samples (summer, 2010)

No.	*Samples*	*mg kg^{-1} soil*				
		Pb	**Cd**	**Cr**	**Hg**	**Cu**
1	SS1	14.91	0.261	9.771	0.324	36.40
2	SS2	33.85	1.453	134.2	0.049	21.80
3	SS3	154.2	0.664	76.37	0.179	10.30
4	SS4	346.0	0.539	171.9	0.342	14.60
5	SS5	131.3	0.630	139.8	0.152	26.50
6	SS6	212.8	0.812	163.7	0.200	16.40
7	SS7	128.4	4.143	62.67	0.104	29.20
	Average	*144.5*	*1.21*	*99.150*	*0.193*	*22.17*
	STDEV	*122.2*	*1.34*	*60.047*	*0.108*	*9.15*

The mean value of Cd found in the sediment was 1.21 mg kg^{-1} dw sediment or twice higher the mean value found in reference soils. The highest values for Cd have been found at SS7, SS2 and SS6; 4.143, 1.453 and 0.812 mg kg^{-1} dw sediment, respectively. The value found at SS6 can be due to the direct influence of effluents coming from the urban area of Ksamil, while at SS7 and SS2 the values are affected by the contributions of the tributaries (Bistrica River and hydro pumping station). The Hg values at Butrint range from 0.049 to 0.342 mg Hg kg^{-1} sediment with a very huge difference (about 8 times). As with the other metals and Hg, the maximal values are found at SS4 and SS1 and SS3 (0.342, 0.324 and 0.179 mg Hg kg^{-1} sediment, respectively). In comparison to the values found in soil, the values of Hg were 1.4 times higher. The mean values of Cr were 99.1 mg kg dw sediment or lower than its mean values in soil, a fact that is conditioned from its water solubility. Cr contents in sediments at some sampling stations are higher than the maximum permissible limits (81 mg / kg) [17]. High Cr values were measured in stations which are located near the main freshwater sources, indicating a transport in the lagoon as weathering products of soil due to Pavla and Bistrica river runoffs. The content of Cu, was also lower than those found in the soil (the mean values found in the soil and sediment were 54 and 22 mg Cu kg^{-1} soil/sediment, respectively). This is explained by the capacity of this element in the cationic form to dissolve in water and thus get transported rapidly. One of the particular factors influencing the cycling of metals within lagoons and coastal areas is their interaction with sediments and their relationship with particle size and composition [18]. Dissolved metals tend to be sequestered from water by fine grain particulate material in the suspended load or settling or in bed sediments.

Table 3. Heavy metals at the surface water of the lake (in µg L-1)

SS/Heavy metals	***Pb***		***Cd***		***Cr***		***Hg***		***Cu***	
Period	May	August	May	August	May	August	May	August	May	August
SS1	1.15	0.78	0.03	0.049	2.04	0.64	0.01	0.09	9.7	10.4
SS2	1.25	0.68	0.02	0.075	0.87	1.84	0.01	0.26	8.3	6.2
SS3	1.01	0.44	0.03	0.047	1.3	0.54	ND	0.27	2.3	4.8
SS4	0.98	0.29	0.06	0.022	0.7	1.45	ND	ND	14.6	27.4
SS5	1.48	0.52	0.03	0.041	0.6	3.77	Nd	ND	11.9	22.1
SS6	1.53	0.93	0.09	0.068	0.7	1.51	Nd	ND	18.7	30.8
SS7	0.64	0.39	0.01	0.039	0.7	1.66	Nd	ND	6.3	9.4
Average	*1.15*	*0.58*	*0.04*	*0.05*	*0.99*	*1.63*	*0.01*	*0.21*	*10.26*	*15.87*
STDEV	*0.31*	*0.23*	*0.03*	*0.02*	*0.52*	*1.07*	*0.00*	*0.10*	*5.42*	*10.67*

3.3 Heavy metals at the surface water of Butrinti lake

One of the objectives of the risk assessment is the assessment of water quality, the environment and the feeding sources of mussels, as well. The mean value of Pb in the water in May was 1.15 μg L^{-1}, the maximal and minimal value 1.53 and 0.64 at SS6 and SS7, respectively; in August almost twice lower (0.58 μg L^{-1}) with minimum and maximum 0.29 (SS4) and 0.93 (SS6) μg L^{-1}. The values in all stations were lower and much lower in relation to the EU reference [19] and the highest values were recorded at SS6 (August), SS5, SS6 (May). All the Cd values were <1, when the values of reference are 1-5 μg L^{-1}. The values of Cu at SS4, SS5 and SS6 in May and August were higher than the EU reference values [19] while Cr values do not pass 5.0 μg L^{-1}in either case. The mean values of Hg were higher in August 0.21 μg L^{-1} while the lowest value was recorded in May (0.01 μg L^{1}).

3.4 Heavy metals at the bottom of the lake

We have sampled and measured the values of heavy metals at the bottom of the lake in May and August in order to compare the values measured at the surface of the lake water and the influences that sediments and/or other factors may have on release and transport.

Table 4. Heavy metals in water (at the bottom) of Butrinti (in μg L-1 water)

SS/Heavy metals	*Pb*		*Cd*		*Cr*		*Hg*		*Cu*	
Period	May	August	May	August	May	August	May	August	May	August
SS1	10.78	1.68	0.03	0.055	2.1	19.8	ND	0.23	10.40	23.10
SS2	7.87	1.3	0.02	0.204	2.22	49.2	ND	0.26	15.60	9.90
SS3	8.97	1.95	0.03	0.164	2.58	36.5	0.07	0.26	8.30	16.70
SS4	3.46	3.78	0.07	0.076	1.5	12.9	0.05	0.29	12.80	32.30
SS5	8.48	3.17	0.06	0.032	0.9	12.4	ND	ND	24.20	28.90
SS6	4.06	7.61	0.1	0.097	0.8	54.6	ND	ND	16.50	47.80
SS7	5.25	1.46	0.1	0.092	0.7	56.6	ND	ND	9.70	13.20
Average	*6.98*	*2.99*	*0.06*	*0.1*	*1.54*	*20.51*	*0.06*	*0.26*	*13.93*	*24.56*
STDEV	*2.75*	*2.24*	*0.03*	*0.06*	*0.77*	*16.55*			*5.45*	*13.08*
Max.	*10.78*	*7.61*	*0.1*	*0.204*	*2.58*	*56.6*	*0.05*	*0.29*	*24.20*	*47.80*
Min	*3.46*	*1.3*	*0.02*	*0.032*	*0.7*	*12.4*	*0.07*	*0.23*	*8.30*	*9.90*

The mean values of Pb in May were 6.98 μg L^{-1} with the maximum in SS1 (10.78 μg L^{-1}) and the minimum in SS4 (3.46 μg L^{-1}); in August the mean values were 2.99 μg L^{-1} but the maximal value was high (7.61 μg L^{1}). The values at SS1 and SS5 in May and SS6 in August were higher than the standards of EU-2008 (7.2 μg L^{-1})[19]. The mean values of Cd in May were 0.06 μg L^{-1} and in August 0.1 μg L^{-1}. The highest values were found in SS2 and SS3 in August, but always under the standard value (<1 μg L^{-1}). The concentrations of metals in the surface water of Butrinti lake are as follows: Cu> Cr> Pb. They correlate with the solubility degree of these elements in water, (their content in soil solution). Cu, Cr and Pb which are the most mobile metals, have a higher concentration in depth.

3.5 Heavy metals in mussels

The data analysis in this section relates to the standards requested by EU for heavy metals, especially Hg, Cd, and Pb, which are the most toxic of the heavy metals. According to Commission Regulation, the maximum acceptable values of concentration in the mussels were ≤ 1.0, ≤0.5 and ≤1.5 mg kg^{-1} mussels' wet weight for Hg. Cd and Pb, respectively.

The mean value of Pb in May was 0.219 mg kg^{-1} mussels wet weight with the minimal value at SS7 (0.08) and maximum at SS4 (0.492 mg kg^{-1}); in August the average value was lower (0.132 μg kg^{-1}). In May and August the highest concentrations were recorded in SS4 and SS6, where Pb concentrations were considerably higher than that in the other stations. What is noticed is a positive linear correlation between the concentrations in mussels and sediment, in each sampling station ($r=0.504$, $p<0.05$ in May and $r=0.470$, $p<0.01$ in August). In each case the concentrations are <1.0 mg kg^{-1} mussels wet weight, or in conformity to the standards requested by Commission Regulations [20].

The Cd concentration average values in mussel tissues were higher in August (0.279 mg kg^{-1} mussels wet weight) and almost twice and three times lower in May (0.11 mg kg^{-1}). The highest value found through all stations and periods was 0.36 mg kg^{-1} mussels' wet weight and belongs to SS2 in August. The concentrations of Cd over 0.3 cited above are at critical limit and need to be monitored continuously. The mean values of Hg concentrations in mussels in May (0.125 mg kg^{-1}) were higher than in other periods, while in August, they were lower (0.025 mg kg^{-1}). The highest values were recorded at SS6 and SS7 (0.119 and 0.148). The maximal values found were 10 times lower than the limit allowed by EU Regulations. No relationship was found between the concentration of Cadmium in mussels and sediment. The difference of Cu means concentration between seasons was lower in comparison to the other metals; the concentrations were 3.43 mg kg^{-1} in May and 3.77 mg kg^{-1} in August. The highest values for all seasons were recorded in SS4 and SS6 and this is related to the intensive mineralization and higher solubility that characterizes this element. The correlation between Cu concentration in mussels and sediment was very strong (r=0.88 in May, r=0.71 in August). Cr concentration in mussels was low <0.500 mg kg^{-1} mussels wet weight with mean values 0.393 mg kg^{-1} mussels wet weight in August. Some authors believe that concentrations in the biota are better indicators of the biological impact than the environmental concentrations, because the organisms incorporate the contaminants into their bioavailable fraction [21].

Table 5. Heavy metals in the mussels samples (mg kg^{-1} mussels wet weight)

SS/Heavy metals	***Pb***		***Cd***		***Cr***		***Hg***		***Cu***	
Period	May	August	May	August	May	August	May	August	May	August
SS1	0.172	0.107	0.116	0.292	0.128	0.373	0.116	0.046	2.78	3.19
SS2	0.2	0.112	0.104	0.362	0.4	0.395	0.1	0.013	2.84	3.09
SS3	0.152	0.141	0.115	0.307	0.09	0.26	0.14	0.026	3.14	2.89
SS4	0.492	0.158	0.106	0.269	0.08	0.45	0.14	0.016	4.17	4.97
SS5	0.23	0.129	0.092	0.321	0.08	0.162	0.115	0.034	2.91	5.03
SS6	0.207	0.176	0.092	0.207	0.44	0.508	0.119	0.02	6.06	4.3
SS7	0.08	0.102	0.145	0.195	0.312	0.304	0.148	0.019	2.13	2.9
Average	*0.219*	*0.132*	*0.110*	*0.279*	*0.219*	*0.393*	*0.125*	*0.025*	*3.43*	*3.77*
STDEV	*0.130*	*0.028*	*0.018*	*0.060*	*0.160*	*0.114*	*0.017*	*0.012*	*1.31*	*0.97*

4.Conclusions

This study has indicated the presence of toxic metals in some points in soils, sediments, water and mussels in the aquatic environment of the lagoon. Generally, the highest values of heavy metals are found in the Vurgu plain with high values of organic matter due to the origin. This study has indicated that the bioavailable metals in the soils around Butrint are Pb, Cu and the less bioavailable are Cd and Cr. These elements are potentially possible to leachate from the soil. The higher concentration of Cu extracted with water can be explained by the fact that copper compounds are used as or in fungicides, insecticides and fertilizers. The mean value of Cd, Pb, Hgi sediments are higher that it found in reference soils and are due to anthropogenic sources including fertilizers pesticides used in agricultural activities, and the effluents coming from the urban area of Ksamil. Cr contents in sediments at some sampling stations are higher than the maximum permissible limits and the natural weathering of rocks is considered as an source of heavy metals concentration in the sediments of Butrinti lagoon. The values of Cu at the surface water and Pb at the bottom were higher than the EU reference. Cu is the most accumulated heavy metal in mussels, it is explained by the fact that Cu was the most available element and the amount of the Cu extracted by DTPA was higher than the other elements Although, our results showed that the toxicity status of the metals studied could not be very harmful for the lagoon waters, it should be noted that there is still a possibility of contamination.

4. References

1. Miho A, Witkowski A**: Diatom (Bacillariophyta) Flora of Albanian Coastal** Wetlands Taxonomy and Ecology: A Review. Proceedings of the California academy of Sciences 2005*,* 56 (12):129–145**.**
2. Dassenakis M, Degaita A, Scoullos M: **Trace metals in sediments of a Mediterranean estuary affected by human activities (Acheloos river estuary, Greece)**. Science of the Total Environment 1995*,* 168: 19-31
3. Stamatis N, Kamidis N, Sylaios G: **Sediment and suspended matter lead contamination in the Gulf of Kavala, Greece**. Environmental Monitoring and Assessment 2006, 115: 433-449.
4. Bryan GW: **Heavy metal contamination in the sea.** In: Johnston R (Ed), Marine Pollution, London, Academic Press 1976, 185-302.

5. Barbieri P, Adami G, Predonzani S, Reisenhofer E: **Heavy metals in surface sediments near urban and industrial sewage discharges in the Gulf of Trieste**. Toxicology and Environmental Chemistry 71: 105-114.Borgmann, U., & Norwood, W.P., (2002) Metal bioavailability and toxicity through a sediment core. Environ. Pollut 1999, 116: 159-168.

6. Malltezi J, Bani, A, Dini, V, Papakroni H, Shehu A, Sulce S: **Spatial and temporal trends of water quality at Saranda bay, Albania**. Fresenius Environmetal Bulletin 2010, 19 (9): 127-138.

7. **AOAC Official Method 974.27 Cadmium, Chromium, Copper, Iron, lead, magnesium, manganese, Silver, zinc in water.** AOAC Official Method of analysis 1995.

8. **AOAC Official Method 977.22. Mercury in water**. AOAC Official Method of analysis 1995.

9. Frank ES, Arsenault EA: **Microwave-assisted sample preparation in analytical chemistry**. Talanta 1996, 43: 1207-1268. DOI: 10.1016/039-9140(96)01882-6.

10. Hassan NM, Rasmussen, PE, Dabek-Zlotorzynska E, Celo V, Chen H: **Analysis of environmental samples using microwave-assisted acid digestion and inductively coupled plasma mass spectrometry: Maximizing total element recoveries**. Water Air Soil Pollut. 2007, 178: 323-334. DOI: 10.1007/s11270-006-9201-3.

11. Lindsay WL, Norvell WA: **Development of DTPA soil test for zinc, iron, manganese, and copper.** Soil Sci Soc Am J 1978, 42:421–428.

12. Gjoka F, Felix-Henningsen P, Wegener Hans R, Salillari I, Beqiraj A: **Heavy metals in soil from Tirana (Albania)**. Earth and Environmental Science 2010. 172 (1-4): 517-527

13. Ma QY, Lindsay WL: **Measurements of free zinc 2+ activity in uncontaminated and contaminated soils using chelation**. Soil Sci. Soc. Am. J 1993, 57: 963-967

14. Castilho P. Chrdon WJ, Salomons W. **Influence of cattle manure slurry application on solubility of cadmium, copper and zinc in a manure acidic, loamy-sand soil**. J. environ. Qual 1993, 22: 689-697.

15. Juste: **Appréciation de la mobilité des éléments en trace du sol**. Sci. Sol 1988, 26:103-112.

16. Christophoridis A, Stamatis N, Orfanidis S: **Sediment heavy metals of a Mediterranean coastal lagoon: Agiasma, Nestos Delta, Eastern Macedonia (Greece)**, Transitional Waters Bulletin TWB 2007, 4: 33-43.

17. Nauen CC: **Compilation of legal limits for hazardous substances in fish and fishery products**. FAO, Rome, Italy 1983.

18. Langston WJ, Chessman BS, Brut GR, Campbell GR, Jones PJ: **The Severn Estuary: Sediments, Contaminants and Biota**. Marine Biological Association of the UK 2007, 19: 176.

19. **Environmental quality standart**. EU Framework Water Directive on 2008,39

20. **Setting maximum levels for certain contaminants in foodstuffs.** EU Commission Regulation (EC) 188, 2006, 20 p.

21. Borgmann U, Norwood WP: **Metal bioavailability and toxicity through a sediment core**. *Environ. Pollut* 2002, 116: 159-168.