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RESEARCH OF HEAVY METALS DISTRIBUTION IN BOTTOM SEDIMENT OF LAKE TALKŠA (LITHUANIA)

BADANIA PRZESTRZENNEGO ZANIECZYSZCZENIA METALAMI CIĘŻKIMI OSADÓW DENNYCH Z JEZIORA TALKŠA (LITWA)

Abstract: The intensification and development of industrial processes has harmful effects of human activities on nature and entire environment. Having performed the assessment of contamination of environmental components, especially geological environment, it is possible to make a quantitative evaluation of the scope of anthropogenic influence and often the hazardousness of such influence on biota and people. This paper presents study results on accumulation of heavy metals in different layers of Talkša Lake. For the sampling of intact structure of the sediment, the turf borer from the ice was used. After the preparation and examination of samples, Pb, Ni, Cr, Zn and Cu concentrations were identified in the laboratory. Concentrations of these heavy metals in sapropel layers were determined in the extracts of sapropel prepared by means of atomic absorption spectrometry. The results showed that sapropel stratifying on the northern shores of Talkša Lake in terms of LAND 20-2005 should be classified as sludge of Category II. That was determined by maximum concentrations of Cr (257.5 mg/kg) detected in the upper horizon of the sludge. Within other horizons, sapropel is not contaminated with heavy metals, and metal concentrations within it could be treated as amount of valuable trace elements. Due to different mixing layers, sapropel recovered from this part of the lake would become valuable excavation widely used for the purposes of economic needs.

Keywords: heavy metals, lake clean, lake sediments, sapropel

Lakes are a great national treasure, they are important from the natural and economic point of view. Lakes are a source of fresh water. They are also used for modern fishculture, development of hunting economy, water sports, recreational and tourism purposes. Therefore, recovery of silted lakes is very important. On the other hand, sapropel is a valuable lake product. In agriculture it is suitable for soil fertilization and as addition to food for animals, and is a good raw material for chemical and even building industry or medicine and in the energy sector because of the matter's chemical and physical properties [1-4].

Lithuania has about 2850 lakes each covering over 0.5 hectare and around 3150 lakes of under 0.5 hectare each. In total, they cover the territory of 91360 hectares [1]. Eutrophication makes lakes decline, and they accumulate sludge, lakeshores get covered with excess vegetation and, consequently, all this entails a serious ecological problem. The process of declining lakes may also be natural, yet anthropogenic contamination adds to a fast-paced silting up of lakes [5-7]. Sapropel may be of different colors: its color is very important as it discloses the quantities of organic and non-organic matters. Jade color shows that sapropel includes chlorophyll, pink means sapropel has carotene, blue color reveals that sapropel includes vivianite, grey means lime addition and black color or a quickly darkening shade means sapropel includes iron. After being pumped out of a lake, sapropel undergoes fast oxidation and loses its natural shade [2, 6].

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The aim of this article is to survey the concentration of heavy metals in sapropel in Lithuanian Lake Talkša and determine whether or not sapropels of such consist qualifies as an agricultural fertilizer.

Materials and methods

Sapropel samples have been taken from Lithuanian the Lake Talkša. The Lake is located 1 km from the center of Šiauliai town. The lake covers 56.2 hectares, it is 2 km long, and its maximum width reaches 550 m. The northern part of Lake Talkša is connected with Lake Ginkūnai covering 16 hectares via 150 m-long and 5 m-wide Kulpė canal covered with reed. Overgrowth of vegetation covers almost all shores of the lake. The samples of lake sediments were taken in winter with a 50 cm-thick ice cover. Having drilled the ice cover to different depths of bottom sediment samples were taken by peat type drills.

To examine the impurity of samples with heavy metals and to find out other settings of sludge, the analysis of the composition of their trace elements is carried out. Impurity of sludge in Lithuanian lakes is usually measured according to the requirements for the use of sludge wastewater for fertilization and reclamation set in LAND 20-2005 (Table 1).

Table 1

Maximum limit values for concentration in sludge

Sludge category	Quantities of heavy metal [mg/kg]				
	Pb	Ni	Cr	Zn	Cu
1st	≤ 60	≤ 45	≤ 60	≤ 200	≤ 60
2nd	61÷165	45÷100	61÷130	201÷660	61÷200

With reference to LAND 20-2005, the sludge which can be used for fertilization and reclamation of quarries is classed to I category of sludge. It is forbidden to use the sludge of II-IV category as fertilizer in the areas which are intended for growing vegetables and fruit trees, but it is allowed to grow field crops within one year after the promulgation on the sowing surface. In case of intention to fertilize the soil with the sludge of II-IV category for the first time, it is necessary to identify the indicators of soil quality: the content of heavy metals (Pb, Cd, Cr, Cu, Ni, Zn and Hg), granulometric composition and pH [8].

Micro-quantities of sapropel heavy metals were analyzed in lined-up solutions from sapropel (extracts) by Atomic Absorption Spectroscopy with the use of Atomic Absorption Spectrophotometer Buck Scientific 210 VGP with acetylene-air flame. 0.5 g of each sapropel sample were digested with a mixture of HNO_3 (65%) and H_2O_2 (37%) at the microwave digester *Milestone ETHOS*. The solution was poured in flasks of 50 cm^3 and diluted with deionised water to the mark of 50 cm^3.

Atomic absorption spectroscopy (AAS) is a spectroanalytical procedure for the qualitative and quantitative determination of chemical elements employing the absorption of optical radiation (light) by free atoms in the gaseous state. In analytical chemistry the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution or directly in solid samples [9].

Results and conclusions

According to its chemical composition, sapropel can be organic, calcareous, siliceous, and mixed (organic-calcareous and organic-siliceous). The quantitative chemical composition of sapropel varies within a wide range depending on maturity, lying depth and formation conditions [1, 9-12].

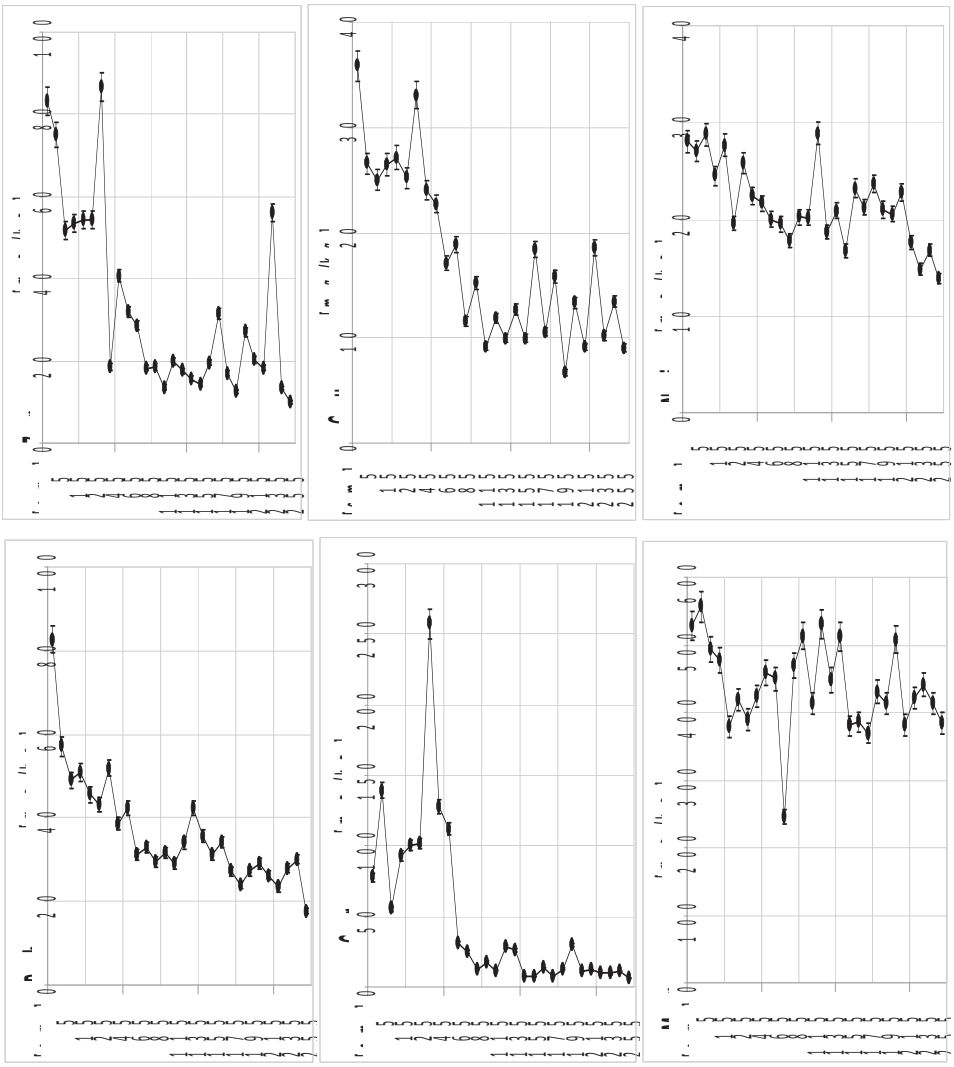

Fig. 1. Variations of heavy metal concentration in the sapropel of Lake Talkša (in vertical profile)

Other studies of *heavy metals* (HM) with the lake sapropel have shown different results. When assessing sapropel in Talkša Lake according to LAND 20-2005, maximum concentration of Cr (257.5 mg/kg) in the upper layer of sludge determined its assign to the sludge of category II. However, mean concentration of Cr (105.3 mg/kg) in the upper layer like the concentrations of others explored, HM of other metals would be classed as sludge of category I. Sapropel in the second horizon is not polluted with heavy metals, and the metal concentrations contained therein can be treated as a content of valuable trace elements.

Vertical section of sapropel in the lake contains horizons which are more polluted with heavy metals, but the following concentration within different depths decreases and does not have great effect on the whole sapropel layer. Assessment report on environmental impact of complex arrangement of Talkša Lake and its approach and installation of international rowing base prepared in Šiauliai in 2003 indicates that the lake sludge is classed to the category I of sewage sludge.

In the past, Talkša Lake experienced significant anthropogenic load. Impact of the "Elnias" leather processing plant on the composition of trace elements of sapropel of the lake is especially significant. Leather processing industry determined the increase in concentrations of pollutants such as Cr and Mn in sapropel. Also, essential influence on the composition of trace elements of bottom sediment had urban wastewater which gets into the lake. Increased amounts of Cr and Zn are formed by the urban wastewater. Transport exhaust gas also has close association with the increase in Pb concentrations. Particulate matter (dust), which are deposited directly, or get into the lake with rainwater drain, also change the natural content of trace elements and their associations.

When assessing sapropel of the northern shore of Talkša Lake under LAND 20-2005, the upper horizon of the sludge is classed to the sludge of category II. In the second horizon, sapropel is not polluted with heavy metals and the metal concentrations contained therein can be seen as the content of valuable trace elements. Sapropel recovered from this part of the lake, due to different mixtures of layer, would become valuable excavation widely used for purposes of economic needs. Researches of heavy metal concentration levels in lakes in Lithuania have revealed that content of sapropel is different in individual cases; and in order to start an expansive use of sapropel it is indispensable to carry out thorough analysis of the matter.

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Abstrakt: Intensywność oraz rozwój przemysłu ma szkodliwy wpływ na człowieka, przyrodę, a także całe środowisko. Po przeprowadzeniu oceny zanieczyszczenia komponentów środowiska, zwłaszcza środowiska geologicznego, możliwe jest dokonanie oceny zakresu oddziaływań antropogennych i często niebezpieczeństwa takiego wpływu na żywe organizmy. W pracy przedstawiono wyniki badań dotyczących akumulacji metali ciężkich w różnych warstwach jeziora Talksza. Próbki były pobierane zimą, do ich pobrania został użyty chwytacz rurkowy. Przygotowane próbki zostały zbadane w laboratorium, stężenia metali ciężkich (Pb, Ni, Cr, Zn i Cu) w różnych warstwach sapropelu wyznaczono za pomocą atomowej spektrometrii absorpcyjnej (AAS). Wyniki analizy wykazały, że według klasyfikatora LAND 20-2005 sapropel pochodzący z północnego brzegu jeziora Talksza należy do II kategorii szlamu. Maksymalne stężenie Cr (257,5 mg/kg) zostało wykryte w górnej części osadu, natomiast stężenia innych metali ciężkich występowały w badanych rdzeniach tylko w ilościach śladowych. Stwierdzone w sapropelu zawartości pierwiastków śladowych nie stanowią przeszkody w wykorzystaniu do celów rolniczych oraz rekultywacyjnych.

Słowa kluczowe: metale ciężkie, osady denne, oczyszczenie jeziora, sapropel