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# Research of Heavy Metals (Cu, Cr and Zn) Concentration in Bottom Sediments of Roadside Water Ponds

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***Abstract*—Pollution of the water ponds with heavy metals is meant to be one of the basic ecological problems in the world. The problems of the environmental pollution with heavy metals are created by intensive growth of the cities, industrial development, growth of intensity of the transport and agricultural progress. Automobile transport is meant as one of the sources of the heavy metals in Lithuania. Such anthropogenic pollution depends on the intensity of transport, richness of the rainfall, composition of the exhaust gas, etc. Pollution of the water ponds that surround two main roads, two national roads and two regional gravelled roads with heavy metals (Cu, Cr and Zn) in particular periods of the year is analyzed in the article. After the experimental analyses were performed, it was assessed that ultimate concentrations of the heavy metals have appeared at spring, when the traffic was the most intensive (21500 automobiles/per day) of the water ponds bottom sediments at the distance of 10 m from the roadside and have reached Cr – 61 mg/kg, Cu – 29,6 mg/kg and Zn – 217,3 mg/kg. Minimal concentrations of the heavy metals of the water ponds bottom sediments were assessed at the environment of the gravel road, where the intensity of the traffic was the minimal (up to 400 automobiles per day) – there concentration of Cr has reached up to 33,8 mg/kg, Cu – up to 17,4 mg/kg and Zn – up to 84,5 mg/kg.**

***Index Terms*— heavy metals, sediments, the roads and intensity of the traffic, the water pond.**

## I. INTRODUCTION

Pollution is of global importance and as such it goes beyond the national borders of each and every nation. The widespread human activity has begun to change the look of our planet as done by a geological force. Water is one of the main existential condition of life in our planet [1]. Exposure of heavy metals to human beings has risen dramatically in the last 50 years. In today's urban and industrial society, there is no escaping from exposure to toxic chemicals and heavy metals [2]-[5]. Heavy metal pollution in aquatic systems has becomea serious threat and has a great potential to cause environmental-derived cancer because these metals arenon-biodegradable and therefore persistent. The pollution of freshwater sources by sewage, industrial waste, oil and agricultural fertilizers and pesticides, endangers the existence of both flora and fauna [6]-[9]. Trace metals enter the aquatic environment from both natural and anthropogenic sources. Entry may be as a result of direct discharges into both freshwater and marine ecosystems, or through indirect routes such as dry and wet deposition and land runoffs [10]-[11]. Urban areas with sources of different contamination in types and scales, provide the ingress of various contaminants and pose hazards to groundwater and soils [12]. Road runoff pollutants are widely recognized as major causes of receiving water pollution [13]. Pollution of the surface-water and the bottom sediments of the water pond with heavy metals, with oil and its products is one of main problem of the environment control. The heavy metals are permanent pollutants that concentrate in the soil, in plants and they do not drift away from them in the natural way. These materials are very dangerous substances that have permanent influence to ecosystems, when they get to environment. The heavy metals when they get into environment may migrate to the depth and to pollute the groundwater [14]-[18].

The territories of the cities, although the industry is not there developed enough, inevitably is polluted by the heavy metals and the pollution with the heavy metals especially high in the bigger cities, in their industrial regions and in the nodes of the traffic [19]. Land use is one of the important factors affecting the water quality in catchments [20]. Traffic is a major source of pollutants in cities. The majority of pollutants showed a similar pattern with respect to traffic intensity: pH and conductivity as well as concentrations of PAHs, total suspended solids, phosphorus and most heavy metals were higher next to high intensity roads compared to low intensity roads. These pollutant levels also decreased considerably up to 5 m distance from the roads [21]. Traffic emissions contribute significantly to the build-up of diffuse pollution loads on urban surfaces with their subsequent mobilisation and direct discharge posing problems for receiving water quality [22]. More content of cromium (Cr), nickel (Ni), cooper (Cu), lead (Pb), zink (Zn) and cadmium (Cd) are detected in the environment of urbanized territories and the roadsides [23]. They are toxic substances that may cause various troubles when they access human organism through nutritional chains [16], [24]-[26]. Trace metals of primary concern for human health and the natural environment include arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), vanadium (V), and zinc (Zn). These trace elements are present in various forms in the environment in water, soil, and air. The organic forms, in particular, are readily taken up and absorbed by biota, and accumulate in food chains, imposing a health risk to wildlife [27]. Heavy metals enlist a relatively large series of elements with specific

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density over 5 g cm$^3$ and relative atomic mass above 40. These pollutants, ultimately derived from a growing number of diverse anthropogenic sources, have had enormous impact on different ecosystem [28].

Road dust is an important non-exhaust traffic source of atmospheric particulate matter, from re-suspension of finer particles carried out by wind and traffic flow. Particles of road dust have both natural and anthropogenic origin; the latter is characterized by higher concentrations of several pollutants and are significantly emitted by other non-exhaust traffic source such as the brake and road wear process [29]. Various pollutants (heavy metals, oil products and suspended particles) drain from the roads together with water of the thaw of the snow and the rain and they pollute surface water, underwater and the soil. Such anthropogenic pollution depends on the intensity of the transport, richness of the rainfall, composition of the exhaust gas, granulated and material composition of the sediments, and distance from the sources of the pollution as well as peculiarities of the sedimentation [30]-[31]. Dominating direction of the wind, growing plants, geomorphological position of the road (whether it is built on the sub-grade or in the pit; whether the road has a trench and what are its slope, whether the road is encircled by the forest or whether the road runs along the opened territory) also influence distribution of the concentrations of heavy metals [32]. That‘s why it is necessary to know distribution of the heavy metals in the environment of the roads, the quantity of them in the soil and in plants, also in the water and in sediments of the bottom as for taking final decision about contamination of the environment and the food.

In Lithuania 70% of total pollution is composed of the pollutants that are discharged by mobile sources of the pollution [33]. The heavy metals are meant as some of the main pollutants of the water ponds located at the roadsides and by this reason, besides of the reason that number of the vehicles is increasing constantly; the purpose is to analyze pollution of the water pools located at the road sides with the heavy metals [32]. Forest road stream crossing approaches, or the section of road immediately adjacent to the stream crossing, represent primary sources and nearly direct pathways for sediment delivery to stream channels [34].

Among many heavy metals that concentrate in the environment of the roads are the following ones: zinc (Zn), chromium (Cr), manganese (Mn), nickel (Ni), lead (Pb) and the cooper (Cu). By reason of the processes of accumulation a fair concentrations of the lead are still remaining at the roadsides. The lead gets into the environment together with the lead oxide inside the tyres material; chromium and the cooper – by reason of moving of the metal parts of the vehicles and also by reason of fraying of the brakes. Manganese likewise as the cooper with chromium can get to the environment by reason of moving of the metal parts of the vehicles and also by reason of the used petrol with manganese additives. The sources of nickel are diesel fuel and the petrol (the exhaust), lubricating oil, nickel-plated metal covering, fraying of the brakes and blacktop of the roads [35]. Zinc as being less dangerous to live organism in comparison with lead, segregate from the tyres of the automobiles and floats on the road as the dust [36].

The aim of the article is to determine the pollution with heavy metals of the water ponds that surround the roads of the different intensiveness during particular periods of the year.

## II. DESCRIPTION OF PLACES OF INVESTIGATION

The water ponds that is located in the environment of two main roads, two national roads and two regional gravelled roads with heavy metals. The pollution with heavy metals (Cu, Cr and Zn) of the sediments of bottom of the 11 water ponds has been examined (Fig. 1).

Three places of investigation were selected in the environmental territory of the main road No. 1 Vilnius–Kaunas–Klaipėda. The place of investigation No. 1 is located at 68 of the kilometres between Vilnius and Kaunas in Kaišiadoriai municipality. The water pond of this place is accreted with the trees and the bushes. The runs were brought to it, along which the waste water of the rain is drained from it trenches located near the main road. The intensity of the traffic along this section of the road is 21500 automobiles per day. The place of investigation No. 2 was located at 206,5 of the kilometres from Vilnius. The place of investigation is within the territory of the town Kryžkalnis of Raseiniai region. 30 km to southwest from the place where the samples were taken is located Tauragė city. 11000 automobiles per day pass along this section of the road. The place of investigation No. 3 was located at 223 kilometres from Vilnius in the territory of Girsteikiai village of Šilalė region. Šilalė city is situating for 15 kilometres beyond the place where the samples were taken. Intensiveness of the traffic of this locality amounts to 10000 automobiles per day.

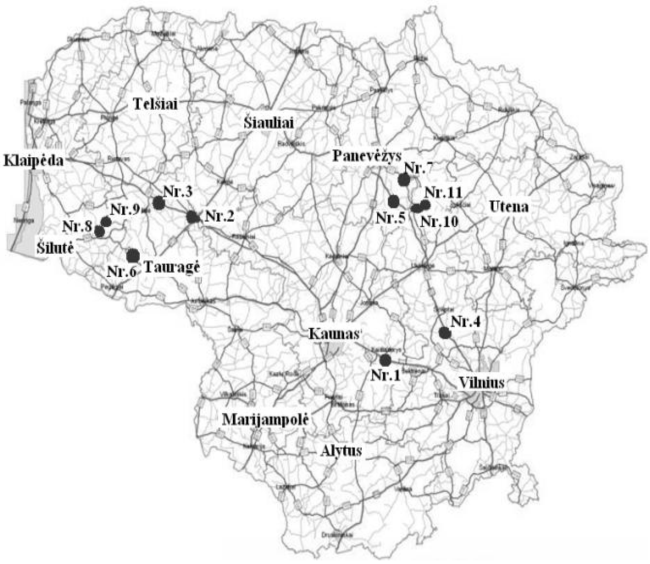


Fig.1. Places of investigation in Lithuania

Two places of investigation were selected in national road No. A2 Vilnius–Panevėžys (namely, the places No. 4 and No. 5). The place of investigation No. 4 is located at 38 of the kilometres between Vilnius and Panevėžys in Širvintos municipality. Along this section of the road 10500 automobiles per day are passing by. The place of investigation No. 5 is located at 112 kilometres from Vilnius in Panevėžys municipality. The water pond that was investigated is located in the opened locality on the slope.

Intensiveness of the traffic of this locality amounts to 10000 automobiles per day.

The place of investigation (No. 6) was selected on the regional road No. 199 Tauragė–Vainutas, which is located at 21,5 of the kilometres between Tauragė and Vainutas of Šilutė municipality. The nearest major city is Tauragė that situates about 25 kilometres from the place were samples were taken. Along this sector of the road up to 1400 of automobiles per day are passing by.

One place of investigation (No. 7) was selected on the regional road No. 121 Anykščiai–Panevėžys, which is located at 40 of the kilometres between Anykščiai and Panevėžys of Panevėžys region municipality. The place of investigation is located in the opened locality and intensiveness of the traffic in this locality amounts to 1400 automobiles per day.

Two places (No. 8 and No. 9) of investigation were selected on the regional road No. 4207 Žemaičių Naumiestis–Pajūralis. The place of investigation No. 8 is located at 7,5 kilometres and the place of investigation No. 9 is located at 10,5 kilometres from Žemaičių Naumiestis of Šilutė region municipality. About 400 automobiles are passing by along this gravel road.

Two places (No. 10 and No. 11) of investigation were selected on the regional road No. 1213 Juostininkai–Ferma. The place of investigation No.10 is located at 7,5 kilometres between Juostininkai and Ferma town of Panevėžys district municipality and the place of investigation No. 11 is located at 6 kilometres from Juostininkai of Anykščiai district municipality. Intensiveness of the traffic of this gravel road amounts to 120 automobiles per day.

## III. Methodology of the Investigation

Flat water pond that cross the road were selected for investigation. The surface layer of the sediments of the bottom was taken 4 times a year (on spring, summer, autumn and before freezing of the water ponds) adrift and at a distance of 10, 20 and 30 metres from the roadway. The sediments of the bottom were taken by uncoloured stainless sludger to and then, after removing the remains of the plants, bulky and rubbish material, they were put to polyethylene vessel that was specially prepared and marked.

The samples were exsiccated and chopped at the laboratory, the inserts and the rubble were extracted also. The exsiccated sediments of the bottom were powdered with porcelain pestle and then they were sifted out through the sieve with eyeholes of the diameter of 1 mm [37]. The sieved samples were poured to porcelain cruets, weighted and they were heated in the muffle furnace at temperature of 450ºC [37]-[38]. 0,5 g of the burnt sample was weighted. The weighted soil was poured to the plastic bag. Then it was moistened with deionised water and 10 ml $HNO_3$ ir 2 ml 30 % $H_2O_2$ was poured by small trickle. Then it was mineralized by mineralizator after selecting proper temperature and the time for mineralization. After mineralisation the cruet was cooled to the temperature of 50–70º C. Out of the cruet the solution was filtered through the glass filter to balloon of the content of 50 ml. After filtering till the mark on the balloon the sample was diluted with deionised water till the mark of 50 ml. The concentration of the heavy metals (Cu, Cr and Zn) is indentified with the help of atomic absorption spectrometer Buck Scientific 210 VGP with air-acetylene flame or by the lead fire [39].

## IV. Results of the Investigation

The samples were taken on April, July, September and November.

*The period of the spring.* During the spring season the utmost Cr concentrations of the water ponds located at the environment of the roads were identified at the place of investigation No. 1 at a distance of 10 metres from the road and they have reached 61 mg/kg (Fig. 2). Cr concentration that was assessed at a distance of 20 metres from the road was for 0,5 % less, in comparison with the concentration that was assessed at a distance of 10 metres and at a distance of 30 metres the concentration was less for 2,6 %. At a place No. 2 where intensity of the traffic was doubly less then at the first place of investigation, the utmost Cr concentration was identified at a distance of 10 metres from the road and it has reached 52,3 mg/kg. Nevertheless, the concentration at a distance of 20 metres was less for 4,3 % then for 10 metres and for 5,5 % major then of the distance of 30 metres. The utmost variations of the concentration in case of receding from the road were assessed at place of investigation No. 4, where Cr concentration at a distance of 10 from the road has reached 45,3 mg/kg and was major for 10,4 % then at a distance of 20 metres and also major for 24,3 % then at a distance of 30 metres. Pollution with Cr of the water ponds that were located in the environment of the gravel roads (investigation places No. 8, No. 9, No. 10 and No. 11) in case of receding from the road has varied marginally and varied from 26,9 % mg/kg to 33,7 mg/kg. The presumption should be made that major chromium concentration that was assessed at the first place of investigation, if to compare them with other places of investigation, by reason of the major intensity of the traffic (up to 21500 automobiles per day).

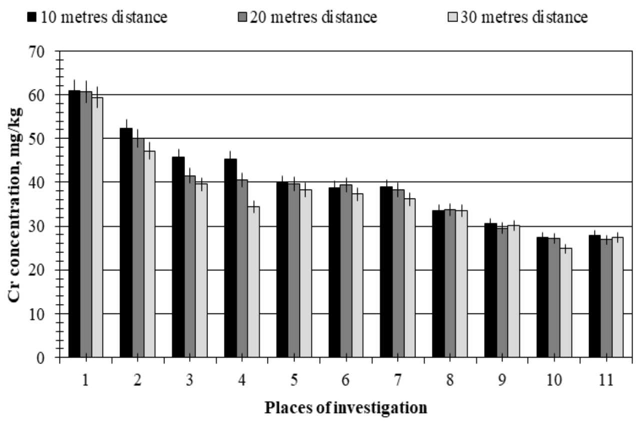


Fig.2. Concentration of Cr in the bottom sediments of water ponds during spring period

The utmost Cu concentrations were identified of the sediments of the water pond (29,6 mg/kg) that was located at the roadway of the sector of the road where intensity of the traffic was the most (the place of investigation No. 1) that have decreased when receding from the road (Fig. 3).

In places of investigation No. 2, No. 3, No. 4, No. 5 and No. 6, independently of intensity of the traffic, Cu concentrations have varied marginally and varied from 19,0 mg/kg (the place of investigation No. 4 at a distance of 30 metres) up to 23,2 mg/kg (the place of investigation No. 3, at a distance of 10 metres). The most Cu concentrations that were identified at places of investigation No. 2, No. 5, No. 6 and No. 10 (respectively 21,57, 20,12, 20,67, 10,63 mg/kg) were at a distance of 20 metres from the road, nevertheless, if to compare them with concentrations that were assessed at a distance of 10 and 30 metres, the difference was marginal and was reaching up to 2,0 mg/kg. If to compare the pollution with Cu of the water pools that were located in the environment of the gravel road, the most variations of the concentrations were assessed at places of investigation No. 8. Cu concentration that was assessed at the distance of 10 metres from the road has reached 16,2 mg/kg and was major for 11,7 %, in comparison with the concentration that was assessed at the distance of 20 metres, and major for 16 %, in comparison with such that was assessed at the distance of 30 metres.

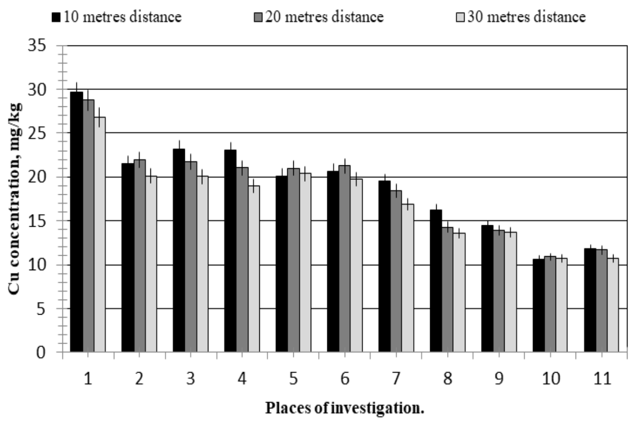


Fig.3. Concentration of Cu in the bottom sediments of water ponds during spring period

During the period of the spring Zn concentration has varied from 45,4 mg/kg (place of investigation No. 11 at the distance of 30 metres) up to 217,3 mg/kg (place of investigation No. 1 at the distance of 10 metres). The place of investigation No. 3 has become distinguished, where maximal Zn concentration was assessed at the distance of 20 meters from the road and it has reached 187,4 mg/kg (Fig. 4). The concentrations at a distance of 10 metres was less for 11,8 %, in comparison with the concentration that was assessed at the distance of 20 metres and less for 11,3 % as the concentration that was assessed at a distance of 30 metres.

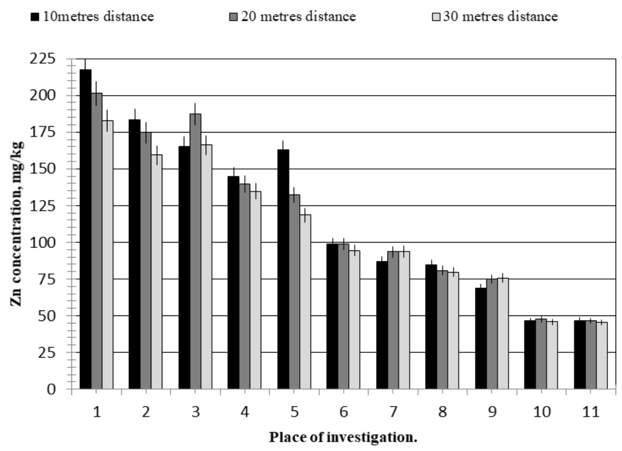


Fig.4. Concentration of Zn in the bottom sediments of water ponds during spring period

Pollution with Zn of the water ponds that were located in the environment of the road where intensity of the traffic was minimal (places of investigation No. 10 and No. 11) has differed marginally one from another and has varied from 45,4 mg/kg up to 47,6 mg/kg. The most variations of the concentrations in case of receding from the road were observed at places of investigation No. 1 and No. 5. Maximal concentration at the place No. 5 was assessed at a distance of 10 metres from the road and it was 162,7 mg/kg.

Zn concentration at a distance of 20 metres was less for 30,3 mg/kg then at a distance of 10 metres from the road and it was major for 14,0 mg/kg at a distance of 30 metres. In the other places of the analysis more conspicuous variations, while receding from the road, were not observed.

*The period of the summer.* During this period Cr concentration has varied from 18,6 mg/kg up to 38,8 mg/kg (Fig. 5). The minimal concentrations were assessed at place of the analysis No. 10, where Cr concentration at a distance of 10 metres has reached 20,3 mg/kg and was better only for 1,9 % then the concentration assessed at a distance of 20 metres and for 0,5 % than concentration assessed at the distance of 30 metres from the road. Cr concentrations that were assessed at the place of investigation No. 1 during summer period were for 1,5 times less than concentrations during spring period. In comparison with spring period, Cr concentrations that were assessed during summer period were less at all places of investigation. Nevertheless, Cr concentration at the place of investigation No. 8 during summer period has differed marginally (up to 3,6 mg/kg) from concentrations that were assessed during spring period. After analysis of dependence of Cr concentrations of the traffic intensity distinct tendencies were not observed. Also when receding from the road, Cr concentration has varied irregularly in all places of investigation, though the most Cr concentrations in many places of investigations were assessed at a distance of 10 metres from the road.

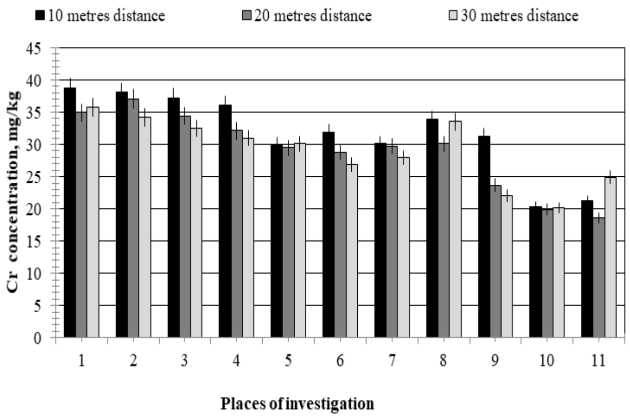


Fig.5. Concentration of Cr in the bottom sediments of water ponds during summer period

Place of investigation No. 11 should be distinguished, where maximal Cr concentration was assessed at a distance of 30 metres from the road, and it had reached 24,9 mg/kg.

Cu concentrations during summer period as well as Cr concentrations, subject to intensity of the traffic along the road has varied without any tendency (Fig. 6). The most Cu concentration was assessed at the first place of investigation at the distance of 10 metres from the road (25,0 mg/kg), it was major for 19,2 % than of the distance of 20 metres and major for 26,0 % than of the distance of 30 metres. The place of investigation No. 5 should be emphasized, were maximal Cu concentration was 17,4 mg/kg. In comparison with spring period Cu concentrations at this place of analysis were assessed as less for 1,2 times. The most variations of the concentrations, while receding from the road were assessed at places of analysis No. 1–4 and No. 8. After analysis of the pollution with Cu of the water pools that were located in the environment of the gravel roads, place of investigation No. 8 should be emphasized, where Cu concentration at a distance of 10 metres during summer period (17,4 mg/kg), in comparison with spring period, was major for 6,9 %. After analysis of the pollution with Cu of the sediments of bottom of the water pools that located at the roadsides of the country (No. 6 and No. 7) both places of investigation shall be emphasized, were utmost Cu concentrations during the summer period were assessed at the major distance than 10 metres from the road: maximal concentration at place No. 6 was assessed at the distance of 20 metres (16,1 mg/kg) and at place No. 7 the concentration was assessed at a distance of 30 metres from the road ( 12,8 mg/kg.).

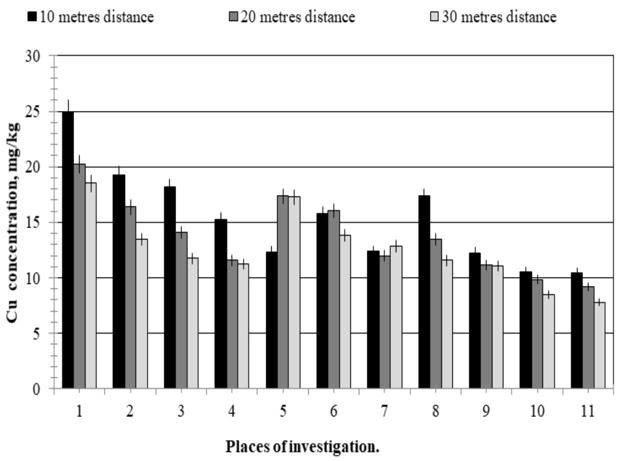


Fig.6. Concentration of Cu in the bottom sediments of water ponds during summer period

Zn concentrations have varied from 35,3 mg/kg (the place of investigation No. 10, at a distance of 30 metres) to 168,4 mg/kg (the place of investigation No. 1 at a distance of 10 metres) (Fig. 7). Investigation place No. 5 shall be emphasized during this period, where maximal Zn concentration (like as Cr) was assessed at a distance of 30 metres from the road and it has reached 123,5 mg/kg.

During this period, in comparison with spring period, in the sediments of the bottom of the water ponds that are located in environment of the main roads Zn concentrations were assessed as less for 1,1–1,4 times.

The most variations of the concentrations, when receding from the road, were assessed at place of analysis No. 1, where Zn concentration at a distance of 10 metres has reached has reached 168,4 mg/kg and was major for 20,5 % then the concentration that was assessed at a distance of 20 metres, also for 18,7 % major than concentration that was assessed at a distance of 30 metres from the road. Pollution of the water pools with Zn that were located in the environment of the gravel roads has varied marginally from 35,3 mg/kg (at place of investigation No. 10) to 56 mg/kg (at place of investigation No. 8). In comparison with spring period Zn concentration was less at all places of the analysis.

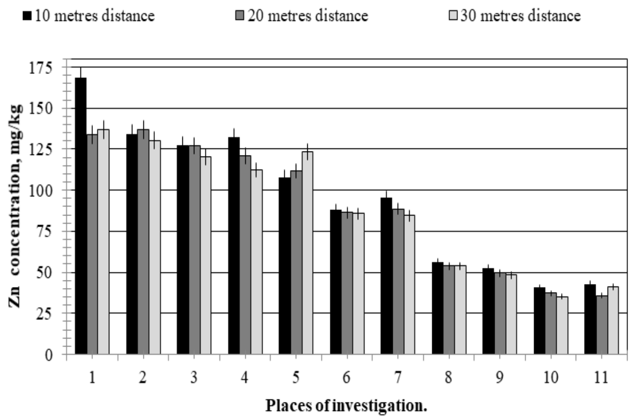


Fig.7. Concentration of Zn in the bottom sediments of water ponds during summer period

*The period of autumn.* During this period major Cr concentrations were assessed than during summer period, but concentrations were less than during spring period (Fig. 8). In all places of investigation, except of the place No. 10, maximal Cr concentrations were assessed at a distance of 10 metres. At place of analysis No. 10 the most Cr concentration was assessed at a distance of 20 metres from the road, which has reached 24,4 mg/kg. At a distance of 10 metres the concentration was less for 4,2 % than concentration, which was assessed at a distance of 20 metres, and it was major for 20,4 % than concentration, which was assessed at a distance of 30 metres. The most Cr concentration was assessed at place of analysis No. 1 at a distance of 10 metres from the road that had reached 53,1 mg/kg, and the less was assessed at place of investigation No. 10 at a distance of 30 metres – it was equal to 18,7 mg/kg.

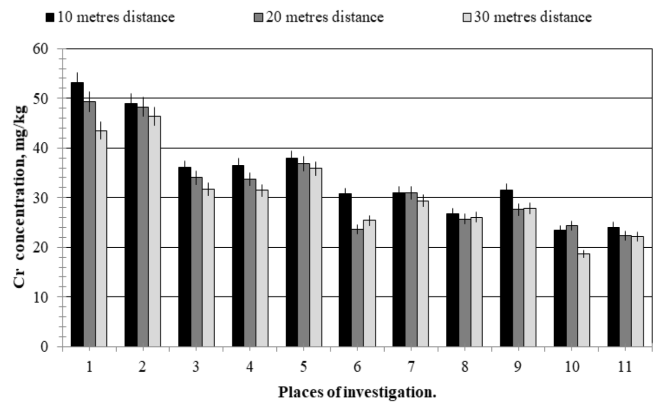


Fig.8. Concentration of Cr in the bottom sediments of water ponds during autumn period

Cr concentration during autumn period, like during of spring and the summer have varied diversely and they didn't depend on intensity of the traffic.

Cu concentrations, like Cr concentrations during autumn period were less than during spring period and has varied from 5,9 mg/kg (No. 10 at a distance of 30 metres) to 25,6 mg/kg (No. 1 at a distance of 10 metres) (Fig. 9).

The utmost variations of the concentrations were assessed at place of investigation No. 2, where Cu concentration at a distance of 10 metres was major for 3,6 % than for a distance of 20 metres and it was major for 34,1 % than concentration at a distance of 30 metres. The pollution with Cu of the bottom sediments of the water pond that was located in environment of the gravel road (the place of investigation No. 9) shall be distinguished. Cu concentrations, when receding from the road, have decreased at all other places of the analyses. Minimal Cu concentrations were assessed in the sediments of the bottom of the water pools that were located in environment of the road of the minimal traffic intensity (up to 120 automobiles per day) and they have varied from 5,9 mg/kg to 8,2 mg/kg.

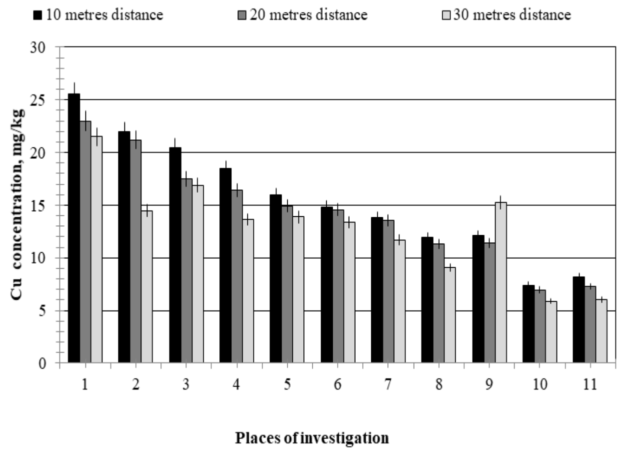


Fig.9. Concentration of Cu in the bottom sediments of water ponds during autumn period

The utmost Zn concentrations during autumn period was assessed at place of investigation No. 1 at a distance of 10 metres from the road, which has reached 200,9 mg/kg, the minimal concentration was assessed at place of investigation No. 10 (47,4 mg/kg) at a distance of 10 metres from the road. The place of investigation No. 5 shall be distinguished, where maximal Zn concentration during the autumn period, like the period of the summer, was at a distance of 30 metres from the road and has reached 128,3 mg/kg.

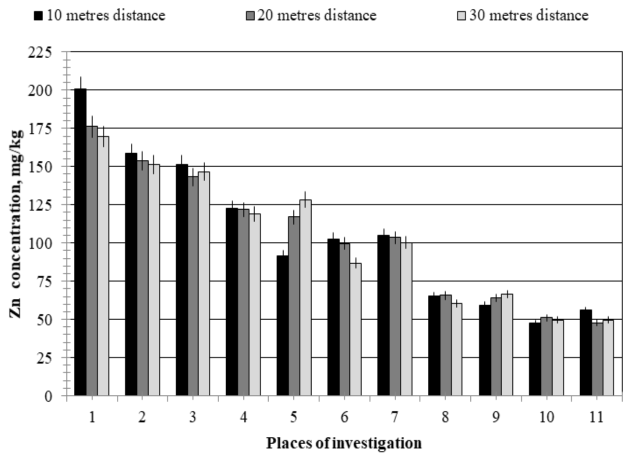


Fig.10. Concentration of Zn in the bottom sediments of water ponds during autumn period

At a distance of 10 metres the concentration was less for 21,6 % than at a distance of 20 metres and for 28,5 % less than concentration at a distance of 30 metres from the road. Zn pollution of the sediments of the water pools those were located in the environment of the gravel roads (the places of investigation No. 8–11) has varied from 47,4 mg/kg up to 66,5 mg/kg. Zn concentration at these places of analysis, when receding from the road, has varied diversely, nevertheless at several places of investigation the difference of the concentrations was marginal (up to 8,1 mg/kg).

*The period before freezing of the water ponds***.** During this period like the other analyzed periods, the distinct alternation of Cr concentrations was not observed considering the intensity of the traffic. Maximal Cr concentrations were assessed at place of investigation No. 1 at a distance of 10 metres from the road and they have reached 50,9 mg/kg (Fig. 11).

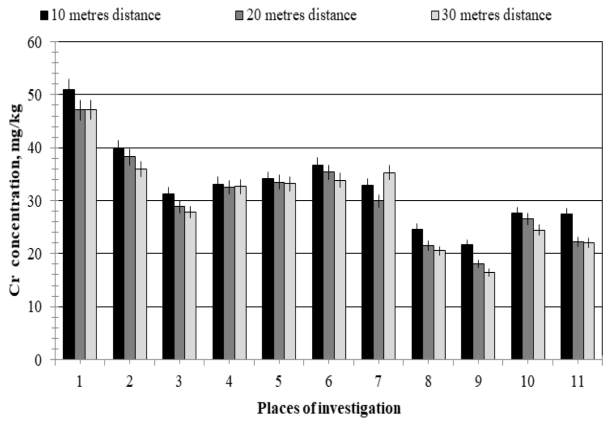


Fig.11. Concentration of Cr in the bottom sediments of water ponds during cold year period

At this place of investigation the concentration was identified that was less for 1,2 times than during the period of spring; it was major for 1,3 times than during the period of the summer and for 1,1 times less than during the autumn period. The pollution with Cr of the water pools those were located in the environment of the gravel roads (investigation places No. 8, No. 9, No. 10 and No. 11), when receding from the road, has decreased and it was maximal at the distance of 10 metres from the road. Nevertheless, the pollution with Cr of the water pools of the roadsides of the less traffic intensity (investigation places No. 10 and No. 11) was major for 1,2 times than the pollution of the water pools of the roadsides, where the intensity of the traffic was better (investigation places No. 8 and No. 9). Maximal Cr concentrations at the most of places of investigation were assessed at a distance of 10 metres from the road, except of place of investigation No. 7, where maximal Cr concentration was assessed at a distance of 30 metres from the road and it has reached 35,3 mg/kg.

In contrast to other periods, the maximal Cu concentration was assessed at the place of investigation No. 2 at a distance of 10 meters from the road (18,4 mg/kg) and it was major for 3,8 % than the concentration at the place of investigation No. 1. Mostly at all places of investigation the maximal Cu concentration was assessed at a distance of 10 metres from the road, except of the investigation places No. 4 and No. 7, where maximal Cu concentrations were assessed at a distance of 20 metres from the road.Cu concentration at place of investigation No. 4 at a distance of 10 metres from the road was less for 1,4 % then concentration at a distance of 20 metres, and major for 8,5% than at a distance of 30 metres (Fig. 12). Cu concentration at place of investigation No. 7 at a distance of 10 metres from the road was less for 6,9 % then concentration at a distance of 20 metres, and major for 3,7 % than at a distance of 30 metres.

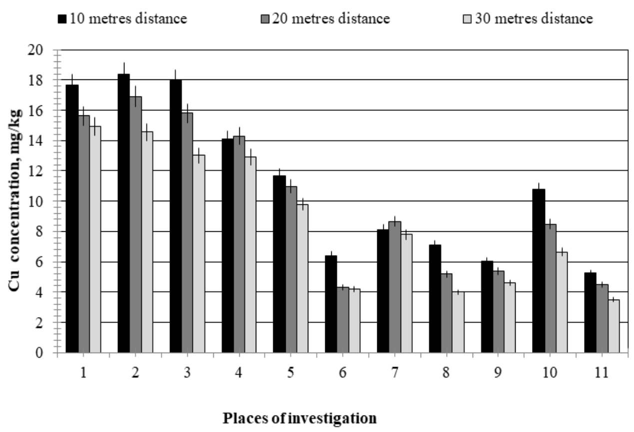


Fig.12. Concentration of Cu in the bottom sediments of water ponds during cold year period

In comparison with other periods of the year, at place of investigation No. 6 minimal Cu concentrations were assessed. Cu concentration at this place of investigation at a distance of 10 metres was 6,4 mg/kg; at a distance of 20 metres – 4,3 mg/kg and at a distance of 30 metres – 4,2 mg/kg. If to collate pollution of the water ponds that are located in the environment of the gravel roads, Cu concentrations have varied differently – maximal of them were found at a distance of 10 metres from the road.

Maximal Zn concentration was assessed at place of investigation No. 1 at a distance of 20 metres from the road that has reached 131,8 mg/kg (Fig. 13). In comparison with other periods of the year, minimal Zn concentrations were assessed during this period. The place of investigation No. 5 has distinguished from all places of investigation mostly, where, if to recede from the carriageway, Zn concentration has increased from 60,4 mg/kg (at a distance of 10 metres) to 100,4 mg/kg (at a distance of 30 metres). The pollution with Zn of the bottom sediments of the water ponds of the national and the gravel roads, when receding from the road, has varied marginally, because the distance from the road had no influence.

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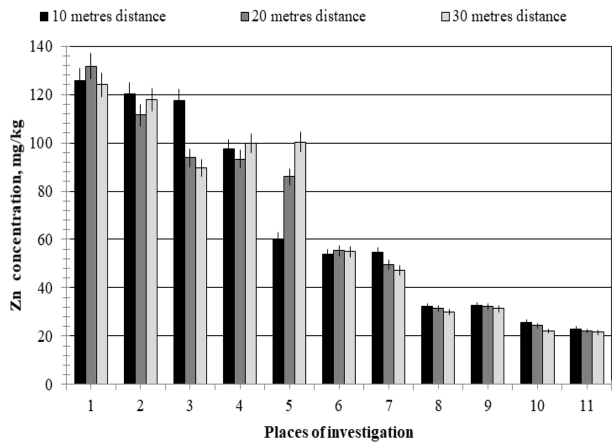


Fig.13. Concentration of Zn in the bottom sediments of water ponds during cold year period

The pollution with Zn of the sediments of the bottom of the water ponds of the main roads, when receding from the road, has varied diversely: at one place maximal concentrations were assessed at a distance of 20 metres (investigation place No. 1) and at other places – at a distance of 30 metres (investigation places No. 4 and No. 5). Zn concentration at the place of investigation No. 3 that was set at a distance of 10 metres (117,6 mg/kg) was major for 20,2 % than the concentration as set at a distance of 20 metres; and major for 23,8 % then the concentration that was set at a distance of 30 metres from the road.

At all periods of the year maximal Zn concentration was assessed at the place of investigation No. 1, which, according to Geochemical Atlas of the Republic of Lithuania, access the utmost zone of pollution, where phonic concentration of the sediments of the bottom is major than 90 mg/kg [40]. In opinion of Portugal scientists, major Zn concentrations may appear for galvanized barriers of the roads [41].

If to compare all seasons of the year, utmost concentrations of heavy metals were assessed during the period of spring. During the period of spring Cr concentration was major for 1,3 times than concentration that was set during the summer period; it was major for 1,2 times then during autumn and cold period of the year. During spring period Cu concentration was major for 1,3 times than during periods of the summer and autumn; and it was major for 1,9 times during cold period of the year. Zn concentration in sediments of the bottom during spring period like Cr was major for 1,2 times then during period of the summer; it was major for 1,1 times then during the period of the autumn and for 1,9 times major than during cold period of the year.

During cold period of the year lesser concentrations might be assessed for reduced intensiveness of the traffic along the roads. The reason of lesser concentrations that were assessed during summer period might be vegetation, because the most of the places of investigation might be overgrown by high grass and the bushes.

Comparable investigations were done by the scientists of the foreign countries (of Germany, Sweden and France). Stopping of the rain water was investigated in Sweden, the water that pollutes the sediments of the water pools with heavy metals. The water pool is near the highway, which average intensity of the traffic is 20000 automobiles a day (Färm 2002). If to compare concentrations of the heavy metals in the sediments of the bottom of this water pond with the concentrations as assessed in the sediments of the bottom of the pond that situates in environment of the road of similar intensity of the traffic (the place of investigation No. 1), the conclusion is that Cr concentrations that were assessed by the scientists of Sweden were lesser for 1,4 times; Cu concentrations were major for 3,2 times and concentrations of Zn were major for 1,5 times.

## V. CONSLUSIONS

1. Maximal concentrations of heavy metals in the bottom sediments of the water ponds were assessed during spring period. Major rainfall amount might have them the importance, or the water of the thaw of the snow, together with which heavy metals have drained to water ponds as located at the roadsides. In comparison with other periods of the year major concentrations of heavy metals as for times from 1,1 to 1,9 were assessed at the spring period.

2. Maximal concentrations of heavy metals (Cr, Cu, Zn) during all periods of the year were assessed in bottom sediments of the water pond, that was located at the roadside of the most intensity of the traffic (21500 automobiles per day) (the place of investigation No. 1): Cr – from 34,9 mg/kg to 61,0 mg/kg, Cu – from 14,9 mg/kg to 29,6 mg/kg and Zn – from 124,1 mg/kg to 217,3 mg/kg.

3. In most places of investigation maximal concentrations of the heavy metals were assessed at the distance of 10 metres from the road. The place of investigation No. 5 should be distinguished, where, when receding from the way, the concentrations of heavy metals have increased. The most it was evident during the summer period. It is evident that the relief might have influence to the situation, because the investigated water pool was located on the slope.

4. Minimal concentrations were assessed in the bottom sediments of the water ponds (the places of investigation No. 8, 9, 10, 11) of the environment of the gravel roads and they have varied during several periods of the year: Cr in the bottom sediments of the water ponds – from 16,5 mg0kg to 33,8 mg/kg; Cu – from 3,5 mg/kg to 17,4 mg/kg and n from 21,6 mg/kg to 84,5 mg/kg. The minimal concentration might be by reason of the lesser activity of the traffic (up to 400 automobiles per day); and also by these reasons that these places of investigation might be outlying from the zones of intensive pollution (from the the cities, from the roads of the intensive movement or other objects).

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