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Impacts of agricultural activities on biogenic matters in stream water

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Impacts of antropogenic activities on the biogenic pollution of water is discussed on an example of physical and chemical parameters of water in East Lithuanian streams such as the Dubinga, Galba, Luknelė, Pavarklas, Peršokšna, Sakiena, Tola, Žvėrupis. Antropogenic activities of agricultural subjects and their effects on biogenic water pollution was determined, and causal relationships were analyzed according to separate spheres of agricultural activities – agriculture and cattle-breeding. The aim of the work was to determine the effect of agricultural activities on the pollution of biogenic matters in streams. The study revealed a correlation between water quality in streams and agricultural activities performed on the banks of these streams (area of agricultural land, number of cattle and poultry). The level of water pollution depended on the percentage of agricultural land in the catchments of streams and on the intensity of agricultural activities. Rivers in the catchments of which agricultural land exceeded 50% of the general area were most severely polluted. An analysis according to Spearman showed a close correlation between the content of pollutants in water and the percentage of the area of agricultural land in the catchments of these rivers, which was very strong for total nitrogen ($r = 0.875$) and strong for total phosphorus ($r = 0.766$).

Key words: biogenic pollution of water, load of agricultural land, animal unit equivalents

INTRODUCTION

Human agricultural activities use the part of fresh water that is constantly replenished due to water circulation. This part of water is found in rivers and water clusters. Under the anthropogenic impact, the wateriness and pollution of rivers change constantly. The effect of anthropogenic factors is greater in catchments of small streams. If water of small streams is used unreasonably, streams may deteriorate completely and have a negative effect on the environmental situation in the location. Pollutants can get into water from point sources of pollution such as sewage system tubes or dung-yards. Water is frequently polluted by sources of split pollution. It may include a surplus of fertilizers or pesticides leached from soil, rainwater sewage. The effects of such pollution may manifest themselves within a long distance from its source.

Scientists from the Polytechnic University of Catalonia carried out research and analysis of nitrogen pollution in surface water clusters of different European regions. Agricultural pollution was found to account for 50–80% of the total nitrogen pollution. Despite obeying the EU Directives on water quality improvement, no decrease of total eutrification took place (Lebedynets et al., 2005; Rovira, Pardo, 2006). Such researches emphasize the slow regeneration of a damaged ecosystem.

At present in Lithuania, like in other EU countries, permissible and forbidden loads of agricultural lands, which cannot exceed 170 kg N/ha a year, are set. A higher concentration of nitrogen in soil makes it possible for nitrogen compounds to get into water clusters (Tripolskaja, Panamariovienė, 1995). Countries with intensive agriculture, cattle-breeding and no environmental restrictions exceed this set rate several times. In regions of intensive agriculture in China, according to a joined project carried out by the Chinese Institute of Soil and Fertilizers, Academy of Agricultural Sciences, Institute of Soil Science, on average 594 kg N/ha of nitrogen is inserted into soil and 256 kg N/ha of production is obtained every year. Such results show that 329 kg N/ha remains in cultivated land every year and gets into surface water clusters due to leaching (Liu et al., 2003; Bin et al., 2005).

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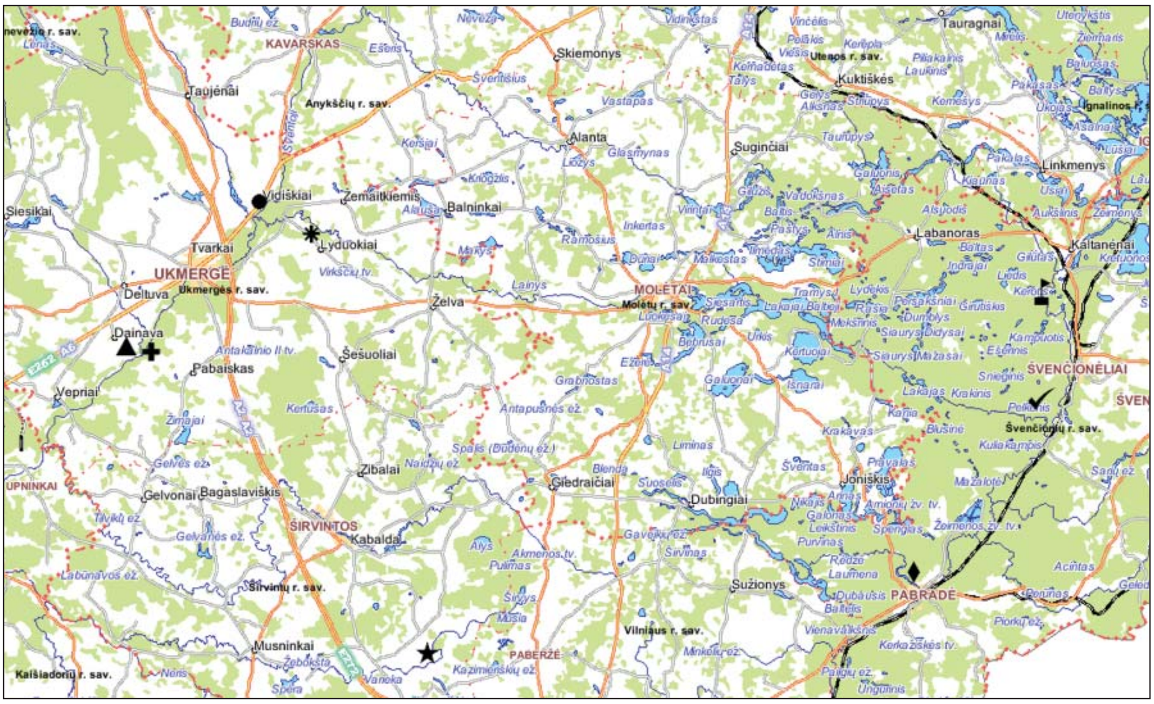
In catchments of Lithuanian rivers, there are slight fluctations in nitrogen and phosphorus leaching in different territories, caused by different reasons, e. g. intensive agriculture in central Lithuania, a great hydro-module in East Lithuania (Chomčenko et al., 2000; Gaigalis, Račkauskaitė, 2001). Migration of mineral nitrogen depends on many factors. More than half of nitrogen leaches from soil in winter and spring, especially in the areas were there is no plant coating (Tula et al., 1997; Bagdanavičienė et al., 2002; Bagdžiūnaitė-Litvinėnaitė, 2005). Because of the typical Lithuanian meteorological conditions with damp and warm periods in autumn, nitrogen composed during the period of greenery decay migrates most actively in October and November and later becomes more active in spring (Ramanovskaja, 2001; Kriaučiūnienė et al., 2006). Norwegian scientists believe that great losses of nitrogen in autumn and winter can be caused by low temperatures which limit nitrogen microbic immobilization (Henriksen, Breland, 1999). Lysimetric research has shown that in East Lithuania most nitrates (29.5–36.3%) leach from soils of a light granulometric composition (Tripolskaja et al., 2002). Nitrogen and phosphorus levels in water are related to the number of cattle in river catchments (Šileika et al., 2000). Cattle and poultry manure, used to fertilize agricultural land, not only increases the phosphorus and nitrogen balance in soil, but also the leaching of these compounds into water clusters. Annual application of manure to soil results on average in 38.3 kg/ha N, or 12.3%, nitrogen leaching from total inserted amount compared to unfertilized soils. Insertion of manure to soil might cause an up to 156.6–180.8 kg/ha increase in nitrogen leaching (Tripolskaja, Panamariovienė, 1995). Such nitrogen losses occur when environmental requirements are observed; however, they might become helpful when soil fertilization rates are exceeded (Adomaitis et al., 2002; Adomaitis et al., 2004; Janušienė, 2004; Maikštėnienė, 2005). Protective territories of water clusters help to reduce access of biogenic matters to soil. In forested areas and meadows, migration of biogenic matters into water tends to be minimal (Granlund, Puustinen, 2006). It has been proved by separate studies that deforestation in river catchments may increase the leaching of biogenic matters into water up to ten times (Okonski, 2007).

The aim of this study was to determine the effect of agricultural activities on the dynamics of biogenic matters in the water of rivulets. To this end, a series of tests were performed: chemical analysis of river water, detecting sources of agricultural activity, calculating nitrogen loads of agricultural lands located in river catchments in relation to the number of farm animals. A relationship between data of various studies was determined.

MATERIALS AND METHODS

The Dubinga, Galba, Luknelė, Pavarklas, Peršokšna, Sakiena, Tola, Žvėrupis – small sreams parts of the Žeimena and the Šventoji catchments in rural areas of East Aukštaitija – were chosen for research. These rivers are located in areas of agricultural activities which differ in intensity of farming, but are similar in the dislocation and concentration of water clusters and in the prevailing turfy sandy loam. To compare the rivers, a relatively clean environment was chosen in the area of the



● Sakiena ▲ Pavarklas ✚ Galba ❋ Žvėrupis ★ Tola ♦ Dubinga Luknelė ✓ Dumblė–Peršokšna

Fig. 1. Places where samples were taken from the rivers

Luknelė river where agricultural activities are insignificant. This area is densely forested, there are very few farms around and thus few sources of pollution, and biogenic pollution includes only background pollution. To ensure the smallest possible measurement bias, a greater part of areas (of eight rivers) was chosen. Water samples from all the rivers were taken in the period of one day twice a year during the time when the greatest amount of biogenic matters is leached, i. e. in March–April and November–December. The samples were examined in 2007–2009. Six samples of water were taken from each river three years in a row, i. e. a total of 48 samples.

All samples from different rivers were taken on the same day to avoid deviations caused by different climatic conditions (Fig. 1).

Places where samples were taken were at river mouths: form the Galba by Sargeliai (Fig. 2), from the Luknelė higher than Lukna (Fig. 3), from the Pavarklas lower than Dainava (Fig. 4), from the Peršokšna-Dumblė near Šeškuškė II (Fig. 5), from the Sakiena near Vidiškiai (Fig. 6), from the Tola near Medžiukai (Fig. 7), from the Žvėrupis near Kurėjai (Fig. 8), from the Dubinga near Kabakėlis (Fig. 9). These places are marked in blue.

At the laboratory of the State Analytic Control Branch at the Department of Environmental Protection for the Vilnius region, the chemical parameters of water from rivers were determined. The spectrometric method was used for determination of molybdate and total phosphorus after oxidizing with peroxydisulfate (LST EN ISO 6878 : 2004) and of total nitrogen by oxidational mineralization with peroxydisulfate (LST EN 12260 : 2004) nitrites using sulfasalicylic acid (LST EN ISO 13395 : 2000).

Data on crops and farm animals were obtained from the Register of Farm Animals, Register of Agricultural and Rural Businesses, Information System of Crop Declaration. Based on the obtained data the parameters of river water quality depending on the intensity of anthropogenic activities were clarified. Different elements of activity were separated into different groups: areas of river catchments, crop areas, the number of farm animals according to groups of their types and age. In the latter case, statistical data from different registers were unified. The collected data were systemized and processed according to different cuts and indexes, using Microsoft Access, Microsoft Excel, Maple 10, Samada 6 – Regres 1.0 module and SPSS 12.0 software. The following

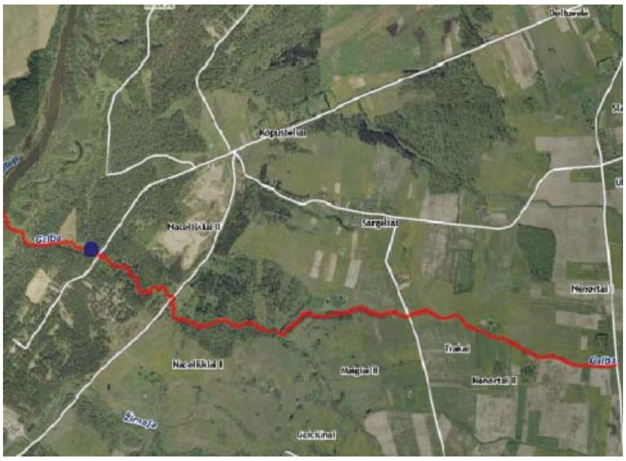


Fig. 2. Galba

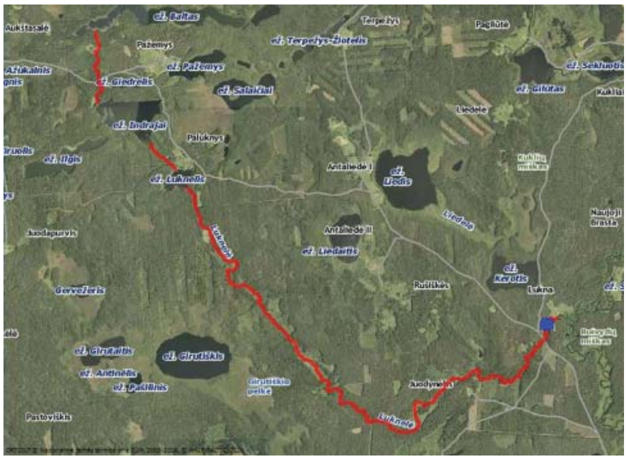


Fig. 3. Luknelė

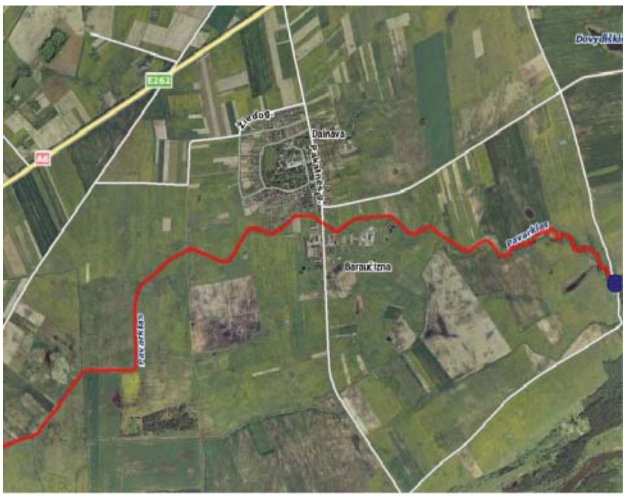


Fig. 4. Pavarklas

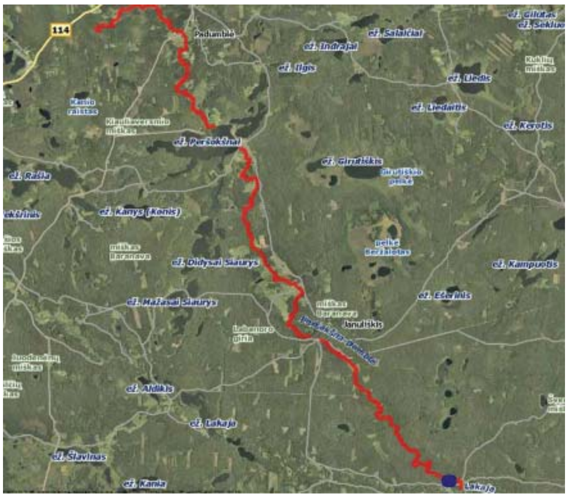


Fig. 5. Peršokšna-Dumblė

Fig. 6. Sakiena

Fig. 7. Tola

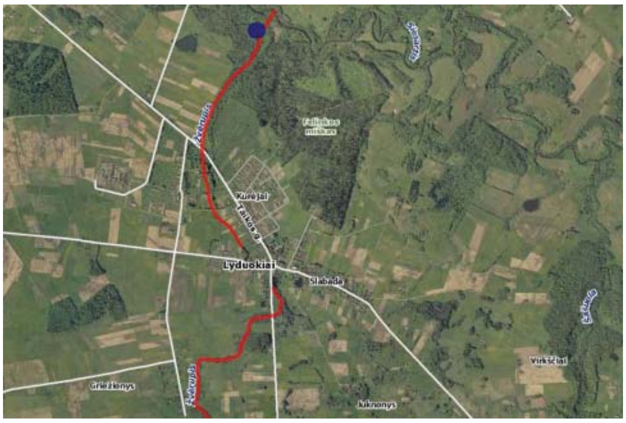


Fig. 8. Žvėrupis

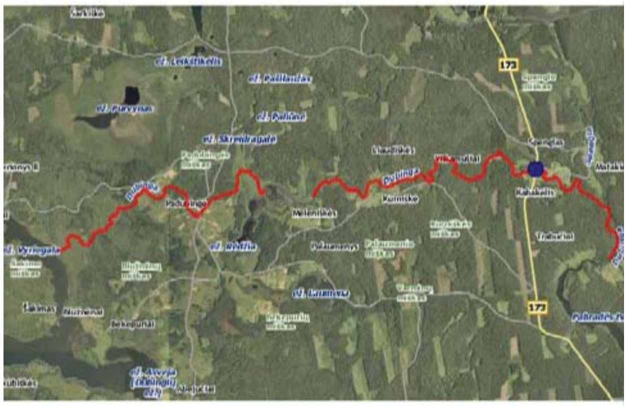


Fig. 9. Dubinga

statistical methods of processing were applied: expression of correlation, percentual deduction, arithmetical means, quality assignment, contraction. To define the distribution of cattle and poultry, we used animal unit equivalents calculated according to coefficients applied in environmental science (Lietuvos Respublikos…, 2007, Nr. 68-2689).

The distribution of crop areas for different river catchments was calculated with the help of GIS (Geographic Information System) using information systems of registration of crop blocks and crop declarations. According to the data on farms registered in 2007–2009 in these locations, every year information was collected about farms, cattle and poultry raised on those farms, and areas of their declared crops. The number of farm animals was calculated according to places of their maintenance (herds and flocks) registered in the area of the stream catchments under investigation. The areas of declared crops were calculated according to crop blocks declared in the informational system. In 2007–2009, the declaration of crops in Lithuania was carried out according to areas which had separate numbers allocated to them. With the help of ArcGis 9.3.1 program, crops and their parts that get into the catchment area of rivulets and thus the area of declared crops in the catchment areas of the rivulets was calculated. Because during the process of declaration registration of meadows and uncultivated lands was carried out, all declared areas are regarded as agricultural lands.

The loads of agricultural lands, based on this information, were calculated according to the formula (Lietuvos Respublikos…, 2007, Nr 21-808):

$$N_{load} = S_{AgL} / AUE \cdot 100,$$

where N_{load} is nitrogen loads N kg/ha, S_{AgL} is the area of agricultural land ha, and AUE stands for Animal Unit Equivalents.

By the causative comparative method, the extent of pollution was analyzed, comparing it with the criteria of agricultural activities (agricultural loads, agricultural areas in catchment areas, animal unit equivalents, ratio of crops and river catchments). On this basis, a causative relationship was determined between the quality of water in the rivers and farming activities, its extent. To determine a correlation among the indexes, the coefficient of correlation was used. Correlation relationships were calculated with SPSS 12.0, the program module according to Spearman.

RESULTS AND DISCUSSION

Assessment of farming activity in the catchment of the streams studied

In order to define the areas that have the greatest effect on the pollution of streams, GIS was used to select the areas of declared crops that are located in the catchments of the study streams. Data are presented in Table 2.

The Dubinga and the Peršokšna have the greatest areas of stream catchments; however the area under crops is small in this territory. The catchments of other streams studied are small, however, crops take up a great part of that area, except for the Luknelė. The largest area under crops was registered in 2007 in the catchments of the Pavarklas stream (388.9 ha) and the smallest area in 2008 in the catchment of the Dubinga stream (10.41 ha).

In the structure of farm animals, the greatest part was taken by cattle which accounted for more than 80% of the total number of all farm animals. According to the assigned coefficients, the average annual number of animal unit equivalents was obtained (Table 3).

Table 1. **Calculation coefficients of animal unit equivalents (AUE)**

Groups of farm animals	AUE
Sows, boars	0.35
Piglets under 2 months of age	0.01
Pigs 2 to 8 months of age	0.1
Pigs over 8 months of age	0.11
Cows, bulls	1
Calves under 1 year of age	0.25
Cattle (increcement) from 1 to 2 years of age	0.7
Red deer	0.2
Fallow deer, sika deer	0.11
American bison, wisents	0.6
Sheep, goats	0.07
Horses over 1 year of age	1
Foals under 1 year of age	0.4
Hens (laying)	0.007
Broilers (cull)	0.0004
Turkeys (bred up to 70 days of age)	0.0064
Turkeys (bred up to 133 days of age)	0.0133
Ducks	0.0086
Geese	0.016
Rabbits	0.025
Chinchilla	0.0014
Minks / martens (adult animals)	0.025
Foxes (adult animals)	0.067
Ostriches (adult animals)	0.4

No farms raising animals were registered in the Luknelė catchment. Catchments of the Dubinga, Pavarklas, Peršokšna, Sakiena, Žvėrupis demonstrate yearly tendencies in animal number reduction. The indexes of the other streams fluctuate insignificantly. The catchment of the Žvėrupis stream was one of the smallest, but it houses one of the biggest numbers of farm animals. In 2007 it had 118.381 AUE. The greatest number of farm animals in 2007 was found in Tola and the Pavarklas the catchments (146.054 and 120.928 AUE, respectively).

Results of stream water research

Nitrogen and phosphorus discharges from crop fields via drains, washed off from animal farms and forested areas affect water quality in the streams. Therefore, while analyzing pollution of stream water, attention has to be focused on the content amounts of biogenic matters in water. The quality of surface water may be considerably influenced by different meteorological, and environmental factors; therefore water samples were taken on the same day. In the water of the study streams, the content of ammonium, nitrites, nitrates, mineral and total nitrogen was determined. The data on total phosphorus are presented in Table 4.

The highest levels of total phosphorus were found in the water of the Žvėrupis and the Pavarklas. The pollution of the Žvėrupis stream in 2009 reached 0.789 mg/l, and in 2007 the pollution in the Pavarklas was 1.124 mg/l. Around these streams, the number of domestic animals kept is one of the greatest, and crops take up the bigger part of stream catchments. Pollution in other streams did not exceed the permissible levels. Although the number of animals in the catchments of some streams gradually decreased, no tendency of reduction in the level of phosphorus was observed in any year. Total phosphorus levels in different years differed up to several times. Similar fluctuation tendencies were observed for total nitrogen (Table 5).

The highest content of nitrogen (8.19 mg/l) was found in 2008 in the water of the Sakiena stream and in 2009 (9.27 mg/l) in the water of the Žvėrupis stream. In the recent years, nitrogen pollution in the Žvėrupis stream has remained increased, although in 2007 it reached only 2.15 mg/l. Fluctuations of nitrogen levels in the Pavarklas stream were very evident, and a sharp increase in certain periods is obvious. Nitrogen content in the water of other streams changed slightly. When data from 2008 and 2009 were compared, a slight improvement of water quality was found in the Dubinga, Galba, Luknelė, Pavarklas, Tola streams.

Table 2. **Area of river catchments and data of crop declaration 2007–2009, ha**

Stream	Dubinga	Galba	Luknelė	Pavarklas	Peršokšna	Sakiena	Tola	Žvėrupis
Catchment of stream	41040	710	3930	1540	15030	570	2450	120
Area of crops in 2007	12.61	48.3	0	1388.9	26.76	290	403.56	84.52
Area of crops in 2008	10.41	34.3	0	963.37	20.64	157.1	387.12	64.2
Area of crops in 2009	11.41	45.42	0	1078.99	14.14	169.42	391.28	62.32

Intensity of agricultural activities and loads

The amount of precipitation, soil structure and relief all tend to contribute to the increased leaching of matters from soil. Regardless of these reasons, when the content of nitrogen and phosphorus in soil is insufficient, only a minimal amount of these matters is leached into water and does not cause water pollution (Gaigalis, 2006). Agricultural and cattle-breeding activities make it possible for biogenic matters to get into water clusters; however, migration of these matters depends greatly on the intensity and loads of agricultural activities. Therefore, we will compare the intensity of agricultural activities with the areas of cultivated land in stream catchments and the percentual expression of how much of a total catchment area is occupied by cultivated land (Table 6).

The average loads of agricultural land were calculated according to declared crop area in a certain year of research and the average calculated number of farm animals. According to the environmental criteria, the loads of agricultural land should not exceed 170 kg N/ha. Loads in the Žvėrupis stream catchment were found to be approaching the maximum limit, and the biogenic matters found in the water of this stream exceeded the permitted rates. The Pavarklas and the Sakiena streams are also polluted with biogenic matters, however, the load of agricultural lands in their catchments is low. Great loads of agricultural lands may not cause stream pollution

Table 3. **Animal unit equivalents in stream catchments, 2007–2009**

Stream	Animal unit equivalents		
	2007	2008	2009
Dubinga	31.937	28.387	28.937
Galba	19.874	14.524	16.25
Gorka	99.572	101.2	99.664
Luknelė	0	0	0
Pavarklas	120.928	99.242	79.222
Peršokšna-Dumblė	30.785	22.285	19.585
Sakiena	13.21	12.04	10.75
Tola	146.054	124.661	127.996
Žvėrupis	118.381	106.737	95.83

Table 4. **Total phosphorus content in water 2007–2009, mg/l**

Stream	2007		2008		2009	
	spring	winter	spring	winter	spring	winter
Dubinga	0.01	0.013	0.111	0.02	0.027	0.023
Galba	0.015	0.112	0.109	0.024	0.076	0.101
Luknelė	0.024	0.021	0.053	0.118	0.039	0.051
Pavarklas	1.124	0.189	0.082	0.075	0.126	0.036
Peršokšna-Dumblė	0.009	0.02	0.045	0.04	0.03	0.023
Sakiena	0.027	0.06	0.072	0.074	0.03	0.07
Tola	0.02	0.065	0.088	0.028	0.072	0.013
Žvėrupis	0.342	0.06	0.173	0.3400	0.42	0.789

Table 5. **Total nitrogen content in water 2007–2009, mg/l**

Stream	2007		2008		2009	
	spring	winter	spring	winter	spring	winter
Dubinga	0.78	0.529	2.66	0.598	0.317	0.403
Galba	2.34	2.79	3.89	5.42	2.25	2.4
Luknelė	0.8	0.296	1.75	1.89	0.351	0.605
Pavarklas	6.4	2.14	6.48	7.79	1.14	5.89
Peršokšna-Dumblė	0.805	0.341	0.518	1.35	3.59	0.774
Sakiena	5.42	2.72	5.98	8.19	7.22	5.96
Tola	5.89	3.43	3.04	1.4	0.432	1.93
Žvėrupis	2.15	2.6	6.89	7.78	6.12	9.27

Table 6. **Concentration and load of agricultural lands in river catchments 2007–2009, N kg/ha**

Stream	2007		2008		2009	
	Loads of agricultural lands, N kg/ha	Crop area in catchment, %	Loads of agricultural lands, N kg/ha	Crop area in catchment, %	Loads of agricultural lands, N kg/ha	Crop area in catchment, %
Dubinga	253	0.03	273	0.03	254	0.03
Galba	41	6.80	42	4.83	36	6.40
Luknelė	0	0	0		0	0
Pavarklas	9	90.19	10	62.56	7	70.06
Peršokšna-Dumblė	115	0.18	108	0.14	139	0.16
Sakiena	5	50.88	8	27.56	6	93.16
Tola	36	16.47	32	15.80	33	15.97
Žvėrupis	140	70.43	166	53.50	154	51.93

Table 7. **Coefficients of correlation between river water pollution and agricultural activities, 2007–2009**

Dubinga	Galba	Pavarklas	Peršokšna-Dumblė	Sakiena	Tola	Žvėrupis
0.99	0.77	0.73	0.86	0.95	0.83	0.85

if they take up only a little part of the whole area of a stream catchment. Agricultural loads by the Dubinga take up only 0.03% of the total catchment area; nevertheless, the loads are high and reach 253 kg N kg/ha. The content of biogenic matters in the water of this stream is low. A small area of agricultural land, even when it has great loads, does not have a significant effect on water pollution with biogenic matters. Water pollution with nitrogen and phosphorus is mostly caused by high concentrations of cultivated land in stream catchments, as is seen from data on the Žvėrupis, Sakiena, Pavarklas stream catchments. However, pollution manifests itself to the greatest extent when agricultural activities are intensive both in cattle-breeding when agricultural land suffers a great load of nitrogen, and agriculture when cultivated land areas occupy a great part of the total area of a stream catchment. A high intensity of such activities is observed in the Žvėrupis catchment.

Effects of farming activities on the quality of water

The relatively clean stream Luknelė has no abundant crops or farm animals on its catchement territory. Biogenic matters in the Luknelė appeared due to background pollution not caused by agricultural activity. Small amounts of total nitrogen and phosphorus were detected in the water of the Peršokšna-Dumblė and the Dubinga. Agricultural land accounted for a small percentage of the total area of catchments of the above streams. The Žvėrupis, Sakiena and Pavarklas were most severely polluted with nitrogen compounds, and the highest level of total phosphorus was found in the Žvėrupis. Areas of cultivated land took up a bigger part of these streams' catchments. A wide choice of stream catchments enabled us to determine the dependence of stream pollution according to Pearson more precisely. The established correlations are presented in Table 7.

In the period 2007–2009, every year the correlation between nitrogen loads in agricultural lands and the concentration of nitrogen in stream water was very strong in the Dubinga (r = 0.99) and the Sakiena (r = 0.95). Data from other streams also demonstrated that nitrogen loads in agricultural lands had a direct effect on the fluctuations of nitrogen in stream water in separate years: the Peršokšna-Dumblė (r = 0.86), the Tola (r = 0.83), the Žvėrupis (r = 0.85), the Galba (r = 0.77), the Pavarklas (r = 0.73). Although it is impossible to assess summarized indexes for catchments of different streams because of their differences, part of the total area taken up by cultivated land and the respective correlations cannot demonstrate the extent of the loads of agricultural lands on water pollution with biogenic matters. Such relationships demonstrate that in the catchment of every stream, under stable natural conditions, migration of biogenic substances might fluctuate depending on the loads

Table 8. **Coefficients of correlation stream water pollution and agricultural performance**

Rates	Agricultural land in watershed, %	Animal unit equivalents
Total nitrogen, mg/l	0.875	0.119
Total phosphorus, mg/l	0.766	0.143

from agricultural lands. Analyzing the total content of biogenic matter in the water of streams and its dependence on different pollution criteria, we calculated the mean indexes of three years according to Spearman. They are presented in Table 8 and Fig. 10.

As one can see from Table 8, the correlation between the content of total nitrogen in water and the percentual expression of agricultural land was strong (r = 0.875). Interrelationship between the variables shows a direct dependence of

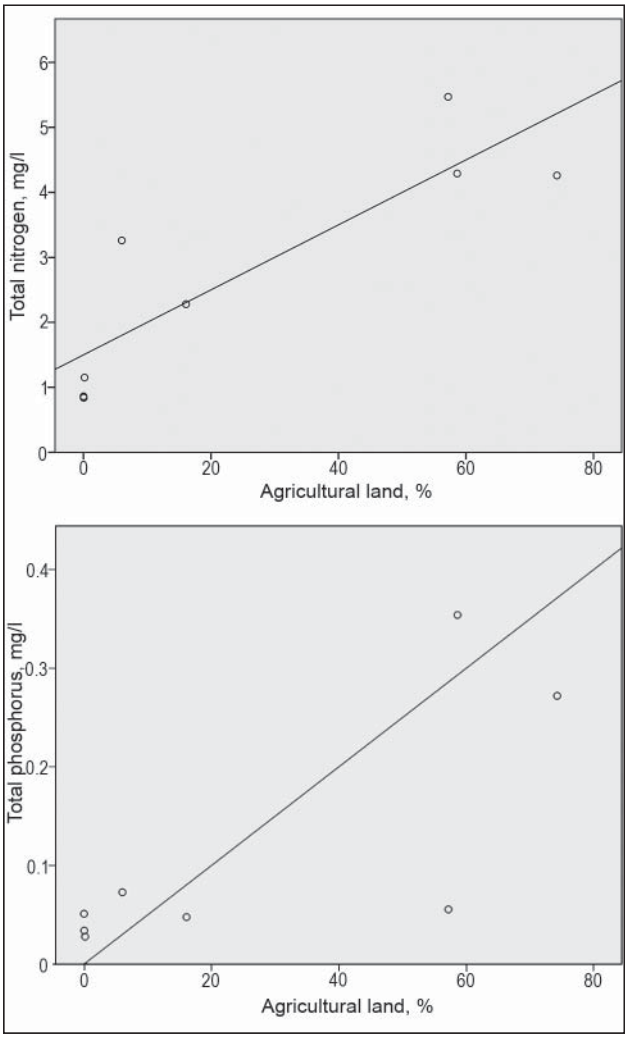


Fig. 10. Correlation between the area of agricultural land in watersheds and pollution with total nitrogen and phosphorus

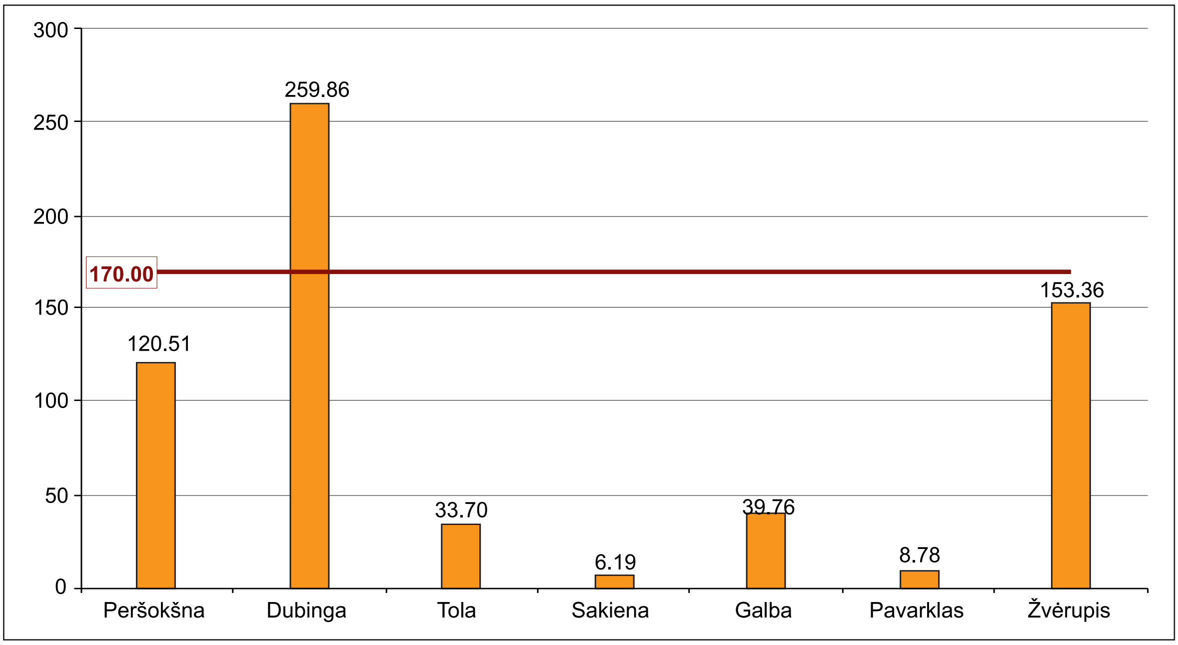


Fig. 11. Loads of agricultural lands 2007–2009, N kg/ha

water pollution with nitrogen on the intensity of agricultural activities. In this case, agricultural activities affect water pollution with biogenic matters more than cattle-breeding does. However, in the stream catchments studied, loads from agricultural lands did not exceed the permissibe levels. Data are presented in Fig. 11.

In the catchment of the Žvėrupis stream, agricultural activities are intensive, nitrogen loads of agricultural lands do not the permissible levels, but nevertheless they are close to the maximum limit, and water pollution with biogenic matters exceeds the permissible limits several times. This only proves that in the regions of intensive agriculture where a great number of farm animals is kept, the leaching of nitrogen and phosphorus into water bodies may be very intensive. Such data allow us to presume that in Lithuania, which is located in a territory of excess humidity, the environmental standards applied generally in all EU countries might be too high. The occuracy of such investigation should be checked by employing the maximum permissible level of nitrogen fertilizers leached into soil and observing water pollution.

The dependence of the content of total nitrogen on the percentage of the total area of agricultural land in stream catchments is very evident (r = 0.7660). The coefficients of correlation between river water pollution and the percentage of area of agricultural land in river catchments were highly significant ($p < 0.01$).

CONCLUSIONS

1. In 2007–2009, yearly fluctuations of total nitrogen and phosphorus in river water depended on the changing load of biogenic matters in cultivated fields.

2. The quality of water in the rivers studied was directly dependent on agricultural activities on the banks of these rivers, i. e. on the area of agricultural land in the catchments of the rivers. The very strong correlation between the content total nitrogen in water and the percentual expression of agricultural land in river catchments for total nitrogen was very strong (r = 0.8750), and for total phosphorus it was strong (r = 0.766).

3. The area of agricultural lands in the catchments of the rivers had a greater impact on the content of nitrogen and phosphorus leaching into water than the number of cattle and poultry on farms.

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ŽEMĖS ŪKIO VEIKLOS ĮTAKA BIOGENINIŲ MEDŽIAGŲ KAITAI UPELIŲ VANDENYJE

Santrauka

Žemės ūkyje vykdomos antropogeninės veiklos įtaka vandens biogeninei taršai nagrinėjama analizuojant Rytų Lietuvos kaimiškose vietovėse esančių mažų upių – Dubingos, Galbos, Luknelės, Pavarklos, Peršokšnos, Sakienos, Tolos, Žvėrupio – vandens fizinius, cheminius parametrus, nustatant žemės ūkio veiklos įtaką upių vandens kokybei. Detalizuojant žemės ūkio subjektų antropogeninės veiklos kriterijus ir jų poveikį upių vandens biogeninei taršai, nustatyti priežastiniai ryšiai pagal žemės ūkio veiklos sritis: žemdirbystę, gyvulininkystę.

Šio darbo tikslas buvo nustatyti žemės ūkio veiklos įtaką mažų upelių biogeninių medžiagų taršai. Atliktuose tyrimuose nustatytas upių vandens kokybės priklausomumas nuo upių pakrantėse vykdomos žemės ūkio veiklos: žemės ūkio naudmenų ploto, gyvulių ir paukščių skaičiaus. Nustatyta, kad upių vandens taršos dydis priklausė nuo žemės ūkio naudmenų ir upių baseinų ploto procentinės išraiškos bei žemės ūkio veiklos intensyvumo. Upės, kurių baseinuose žemės ūkio naudmenų plotas buvo didesnis kaip 50 % upių baseino ploto, turėjo didžiausią biogeninių medžiagų taršą. Apskaičiuojant koreliaciją pagal Spirmeną, nustatyti bendrojo azoto kiekio vandenyje ir žemės ūkio naudmenų ploto procentinės išraiškos baseine ryšiai ($r = 0{,}875$). Nustatyti bendrojo fosforo kiekio vandenyje ir žemės ūkio naudmenų ploto procentinės išraiškos baseine stiprūs koreliaciniai ryšiai ($r = 0{,}766$).

Raktažodžiai: upių biogeninė tarša, žemės ūkio naudmenos, sutartiniai gyvulių vienetai