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Loading and retention of phosphorus in riverine systems

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The catchment of the Dovinė river (right tributary of the Šešupė river, the Nemunas catchment) is situated in the Žuvintas Biosphere Reserve. However, anthropogenic pressure due to agriculture, fishery and urbanization is observed in this catchment. There are forests (33%), agricultural lands (34%), swamps (21%) and water bodies (8%) in the Žuvintas Biosphere Reserve. There are about 1000 plant species (30 of them protected) and 2500 animal species (2200 invertebrates, 220 birds, 15 amphibians and reptiles, 21 fishes, and 43 mammals) in this reserve. The recent transformation of the hydrochemical and hydrophysical conditions, as well as of the former habitats is caused by the huge amounts of biogenes observed in the water bodies of the biosphere reserve and in the other lakes of the Dovinė river catchment. The ecological situation in the river catchment is investigated considering the distribution of phosphorus in the riverine system. According to the observation results, the annual inflow of phosphorus reaches 15200 kg P y^{-1} (78% of it is the anthropogenic phosphorus) in the Dovinė river catchment. There is about 7960 kg P y^{-1} retained in the five largest lakes of the basin. The lowest content was found in Lake Dusia (80 mg m^{-2}) and the highest in Lake Simnas (980 mg m^{-2}).

Key words: the catchment of the Dovinė river, Žuvintas Biosphere Reserve, phosphorus load, phosphorus retention, eutrofication

INTRODUCTION

The influence of land use on riverine systems is a frequent object of research. Nutrient losses from agricultural catchments are especially visible. The augmentation of eutrophication, which depends on the ratio of phosphorus and nitrogen, is observed in such conditions. Nitrogen levels are normally high in the catchments of rivers and lakes situated in plains. However, the lack of phosphorus due to its loading in pristine conditions reduces euthrophication processes. Therefore, the inflow of anthropogenic phosphorus accelerates the euthrophication of water bodies. The phosphorus and nitrogen ratio changes significantly after deforestation or under intensive agricultural activity. For example, nutrient ratios in streams were altered from P to N ratio of 1:120 before deforestation to 1: 33 after deforestation in the United States (Gergel et al., 2002). This is related with the augmentation of phosphorus outflow from eroded lands. However, there are several phosphorus sources that increase euthrophication in river catchments. For example, there are several point sources of phosphorus (Simnas fishery ponds, settlements situated in the river valley and exploited peatlands), as significant as phosphorus losses from agricultural land in the Dovinė river catchment characterised by melioration channels and a scarce forest cover. These facts impede the sustainable management of the catchment.

During the intensive and unsustainable catchment's usage, the amount of mineral phosphorus increased up to 10 times in some places of the Dovinė river cathment (Tamošaitis et al., 1986) and influenced the outflow of phosphorus from the catchment to the Baltic Sea, i.e. phosphorus load increased continuously. However, the influence of phosphorus increase was strongest on lake euthrophication in the catchment.

There are several lakes characterised by different trophic conditions in the Dovinė river catchment. Žuvintas is the main lake in the Žuvintas Biosphere Reserve situated in the central part of the Dovinė river catchment. Due to euthrophication, the area of the lake was decreasing by 0.2 ha each year during the period 1934–1960. The water volume diminished almost by half in the same period (Bieliukas et al., 1962). The decrease of the lake area and water volume continued in the second half of the 20th century (Taminskas et al., 2005). The overgrowth with aquatic macrophytes decreases the lake's area. A high inflow of biogenes, especially phosphorus and organic matter, from the catchment accelerates the dominance of macrophytes.

Rapid euthrophication processes are also observed in the Amalvas and Simnas lakes of the Dovinė river catchment. The overgrowth of Lake Simnas with macrophytes has been especially rapid over the last three decades. The lowest euthrophication is found in Lake Giluitis. There are no fundamental changes in the euthropication of Lake Dusia situated in the upper reaches of the catchment.

The main goal of the present work was to evaluate the main phosphorus sources in the Dovinė river catchment, its retention in the lakes and outflow from the catchment.

MATERIALS AND METHODS

There are five lakes bigger than 100 ha in the Dovinė river catchment (Fig. 1). Lake Dusia, situated in the upper reaches of the catchment, is the largest, the deepest and characterized by the longest hydraulic residence time (Table 1). There are 9 creeks flowing into this lake and one outflow (the Spernia). The riverhead of the Dovinė River is called Spernia. The largest influent of Lake Dusia is 10.3 km long and its catchment is 25.3 km². This creek was used for the evaluation of phosphorus outflow from the agrarian catchment (Fig. 1, point 1). Phosphorus load from the lake was measured in point 2.

There is a small pond, Kalesnikai, situated between lakes Dusia and Simnas. The Simnas fishery ponds (the total area 113 ha) were established below the Kalesnikai pond in 1965. There are young fish cultured for the pisciculture purposes in the Simnas fishery ponds. The river water compensates for the lack of water caused by the evaporation in the ponds. The surplus of water is released from the ponds towards the river without any cleaning. A large part of young fish die directly in the ponds, causing the augmentation of organic phosphorus. Water sampling was done above (Fig. 1, point 3) and below (Fig. 1, points 4, 5) the fishery ponds.

The name of the creek that crosses Lake Simnas is Spernia above the lake and Bambena below it. The creek,

Table 1. **Morphometric parameters of the Dovinė river cathcment lakes**

Lake	Area, ha	Average depth, m	Maximum depth, m	Catchment area, km²	Hydraulic residence time, y^{-1}
Dusia	2334	15.4	32.6	107.8	16.67
Simnas	244	2.3	4.0	176.8	0.17
Giluitis	234	9.14	22.0	34.8	2.85
Žuvintas	971	1.2	3.4	344.9	0.19
Amalvas	194	1.0	2.9	128.5	0.08

Table 2. **Land use (%) of Dovinė river catchment lakes**

Lake	Land use	Urban territories	Forests	Wetlands	Lakes
Dusia	65	0.9	7.7	3.2	23.2
Simnas	68.9	1.8	8.3	4.3	16.7
Žuvintas	47.1	1.2	10	29.2	12.5
Dovinė river catchment, total	62.2	2.6	12	15.6	7.6

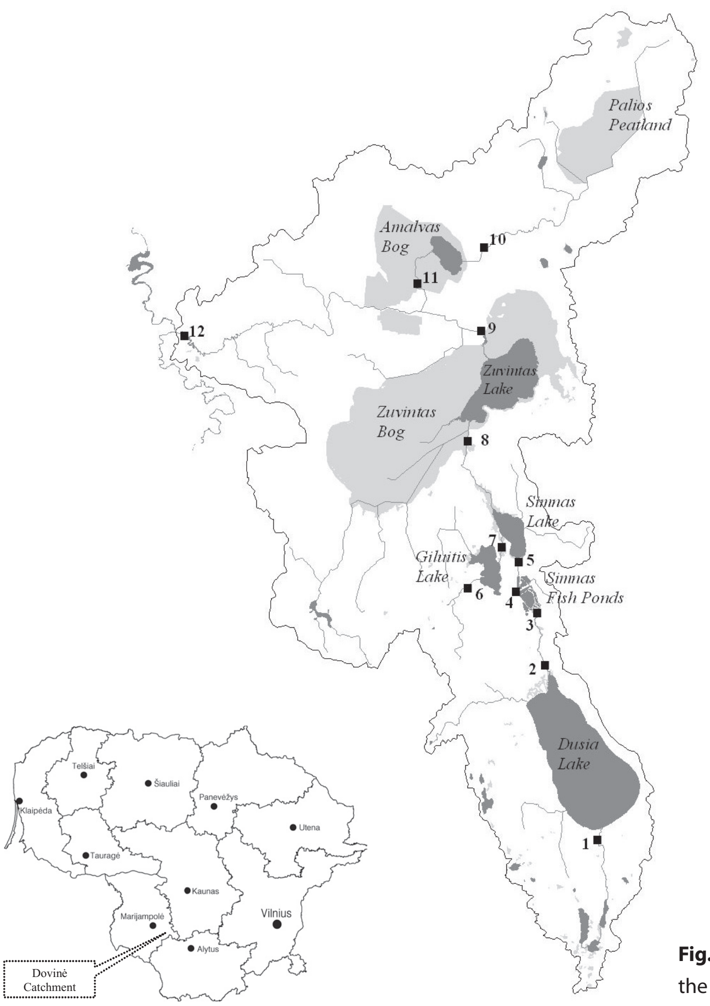

Fig. 1. The Dovinė river catchment (1, 2, 3... – sampling sites in the rivers in 2004/2005)

with a catchment of 35.7 km², flows from Lake Giluitis and falls into Lake Simnas. The agrarian catchment of Lake Giluitis is drained by four small creeks. Water sampling was made above (point 6) and below (point 7) the lake.

The Bambena crosses the agrarian landscape below Lake Simnas as well as a fen just above Lake Žuvintas where its stream is regulated. There are two more creeks falling into Lake Žuvintas. One of them drains only the Žuvintas wetland, whereas the other, falling into the Bambena just before the lake, has a catchment of 98 km² characterised by intensive agricultural activities. Water sampling was done above (point 8) and below (point 9) Lake Žuvintas.

The river below Lake Žuvintas is called Dovinė, with its biggest inflow Amalvė (137.4 km²). The Amalvė river crosses the regulated and shallow Lake Amalvas (Table 1). The source of this creek is situated in an exploited peatland. Below it, the Amalvė drains the agricultural landscape. Water sampling was done above (point 10) and below (point 11) the lake. Water sampling was done also in the river mouth (point 12).

The hydrochemical research of Lake Žuvintas and its influents as well as of the other lakes of the Dovinė river catchment started in 1953 (Klimkaitė, 1962). However, a more detailed analysis of phosphorus in the Dovinė river catchment was made in 1985 for the first time. The concentration of N_{min} increased twice and the concentration of P_{min} 10 times in the Bambena creek in 1953–1985 (Tamošaitis et al., 1986). According to later investigations, the inflow of phosphorus to lakes Žuvintas and Simnas remains one of the main causes of euthrophication up till now.

The monitoring of lakes Dusia and Žuvintas was carried out in 1993–2005 (Valstybinė..., 1998). The Pin–Matra project "Management and Restoration of Natura 2000 sites through an Integrated River Basin Management Plan of the Dovine River" was carried out in this catchment during 2004–2005. Within this project, water sampling was done in the Dovinė river, starting from Lake Dusia up to the river mouth and in the creeks (Fig. 2) in order to measure phosphorus levels (8 times in 2004 and 6 times in 2005). Besides the water samples taken above and below lakes Dusia, Simnas, Giluitis and Amalvas, water sampling was done also in the other cross-sections of the Dovinė river (Fig. 3), in the wells of the settlements situated near the river, at the Simnas sewerage discharge point, in the Simnas fishery ponds as well as in the rainfall gathered in the Dovinė river catchment.

The spectrometric method was used to measure total phosphorus (P_t) in the samples. The oxidation in the acid environment of phosphorus compounds transformed ammonium persulfates into the soluble orthophosphate. The latter concentration was measured using ammonium molibdate. Mineral phosphorus (P_{min}) was measured by the reaction of orthophosphates with molibdate in an acid environment (Fosforas..., 1994).

In order to evaluate the phosphorus load from the limnoglacial relief, the earlier phosphorus research studies (1953–1960) in the almost pristine Dovinė river catchment (Sūduvos..., 1960; Tamošaitis et al., 1986) as well as phosphorus load data from almost pristine Dusia creeks were used (Lietuvos, 1986).

A fixed specific discharge (5.8 l s^{-1} km²) and baseflow (2 l s^{-1} km²) were taken in order to calculate phosphorus load in Lake Dusia catchment (Симнишкайте, 1972). According to the data of previous researches, the total phosphorus concentration in the water getting into the hydrographical network in pristine conditions (phosphorus load in pristine conditions) was about 0.02 mg P

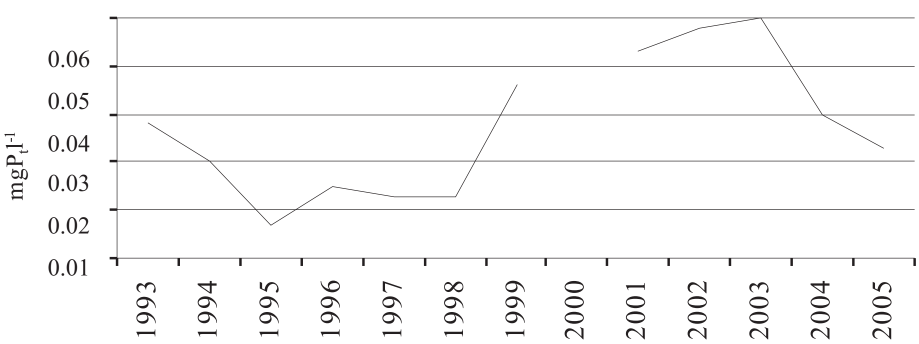

Fig. 2. Average annual total phosphorus content in Lake Dusia

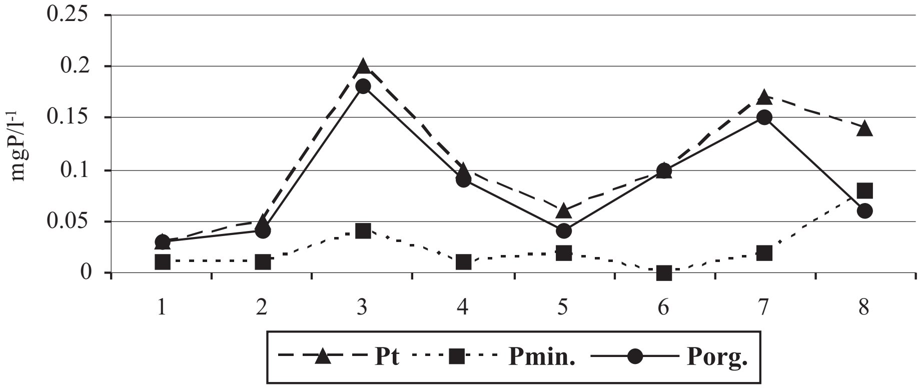

Fig. 3. Phosphorus fluctuation in the longitudinal section in the Dovinė river during 2005: 1 – below Lake Dusia; 2 – above Simnas fishery ponds; 3 – above Lake Simnas; 4 – below Lake Simnas; 5 – above Lake Žuvintas; 6 – below Lake Žuvintas; 7 – the Dovinė river near Daukšiai settlement; 8 – mouth of the Dovinė River.

l^{-1}. Phosphorus load from urbanised territories (GD) was measured according to its concentration in water wells and groundwater sources as well as the baseflow. The surface inflow of phosphorus (SI) was measured according to the fixed specific discharge and phosphorus concentration measured in the lake influents. Analogous estimations were made to indicate phosphorus surface outflow (SO).

RESULTS AND DISCUSSION

Annual phosphorus surface inflow to Lake Dusia was about 0.18 kg P ha^{-1} during an intensive farming period in the 8–9th decades of the 20th century (Tamošaitis et al., 1986). This amount has diminished in the period 1992–2005. However, according to earlier studies (Sūduvos..., 1960; Tamošaitis et al., 986), annual phosphorus surface inflow from the pristine catchment was about 0.09 kg P ha^{-1}. An extremely low level of phosphorus (up to 0.05 mg P l^{-}1) was observed in Lake Dusia and in the other lakes of this region in 1960. No phosphorus was found in the surface layer (up to 5 m) of the water. Generally, the total phosphorus varied from 0.01 to 0.04 mg P l^{-1} in the lakes (Sūduvos..., 1960). According to other sources (Tamošaitis et al., 1986), phosphorus amount from the pristine landscape varied 0.01–0.02 mg P l^{-1} in an uncontaminated lake in the 6th decade of the 20th century.

Recently, the surface inflow of phosphorus to Lake Dusia reaches approximately 0.135 kg P ha^{-1} (1090 kg P y^{-1}) of which 25% is anthropogenic phosphorus from the farming territories. There is about 50 kg P y^{-1} getting into the lake with groundwater discharge. Finaly, 55% of all phosphorus load comes into the lake with rainfall (0.64 kg P ha^{-1} (0.123 mg^{-}l^{1}) per year).

The average annual total amount of phosphorus was 0.036 mg P l^{-1} (maximal – 0.055 mg P l^{-1}) in the outflow of Lake Dusia (Fig. 1, point 1) in 2005. This exceeded insignificantly (up to 0.03 mg P l^{-1}) the total phosphorus in the uncontaminated lakes. Similar phosphorus levels (average 0.039 mg P l^{-1}) were observed in 1994–2005 (Fig. 2). As the intensity of the farming activities slowed down in the last decade of the 20th century, the average annual total phosphorus level in Lake Dusia decreased. According to this parameter the lake is treated as uncontaminated one. However, the recovering farming activities influenced the augmentation of phosphorus amount since 1999. It became almost the same as compared with the intensive farming period when total phosphorus reached even 0.156 mg P l^{-1} in the water of Lake Dusia. It was less than 0.03 mg P l^{-1} very rarely. The average total phosphorus was 0.069 mg P l^{-1} in the lake in 1984–1986 (Lietuvos..., 1986).

There were about 400 kg P y^{-1} losses from Lake Dusia in pristine conditions. Annual losses were 760–960 kg P y^{-1} (average 700 kg P y^{-1} or 0.065 kg P ha^{-1}) from Lake Dusia in 1999–2005. Approx. 1860 kg P y^{-1} (i. e. 80 mg m^{-2}) was retained in the lake.

Lake Dusia was considered uncontaminated approximately up to the 8th decade of the 20th century. Later, due to the intensive farming activities, it became a lake with a phosphorus level at which plant growth was stimulated.

Recently, the situation is improving. The phosphorus (in kg y^{-}1) balance equation is

$$1090\,SI + 50\,GD + 1420\,PI - 700\,OF = 1860\,RET,$$

where SI is surface inflow, GP is groundwater discharge from the urban area, PI is precipitation, OF is outflow from lake, RET is retention in the lake.

Phosphorus content is increasing in the water between Lake Dusia and the Simnas fishery ponds. However, it did not exceed 0.055 mg P l^{-1} above the fishery ponds. The highest phosphorus content (0.044–0.055 mg P l^{-1}) was observed after the vegetation period, whereas it varied only from 0.017 up to 0.039 mg P l^{-1} during the vegetation period. The concentration of phosphorus insignificantly exeeds its load in the pristine conditions in this point. This increase is influenced by organic phosphorus load after the vegetation period as well as by the minimal environmental pollution from the river sources up to the Simnas fishery ponds.

The catchment area increases only by 6.8 km² between Lake Dusia and the fishery ponds. However, phosphorus load augments to 260 kg P y^{-1} (0.382 kg P ha^{-1}). The relatively high level of phosphorus in this section is influenced by domestic sewage and groundwater discharge. Domestic sewage is a very important source of phosphorus for shallow groundwater, water wells and suface water (Muller, Hesel, 1999). That is one of the main reasons influencing the augmentation of phosphorus levels in the river's water even up to the fishery ponds (Fig. 3, point 2). It is reflected by phosphorus content in shallow groundwater. The concentration of total phosphorus varied from 0.094 to 3.9 mg P l^{-1}, of mineral phosphorus from 0.088 to 3.41 mg P/l, organic phosphorus from 0 to 0.589 mg P l^{-1} in the water wells situated in the river valley and fed by shallow groundwater. The average concentration of total phosphorus was 1.279 mg P l^{-1}, organic phosphorus 0.188 mg P l^{-1}, mineral phosphorus 1.091 mg P l^{-1} in the water wells.

Phosphorus enters the water wells situated in the Dovinė river valley with sewerage from leaky septic systems. A lot of the inhabitants of the Spernia valley are not connected to the municipal water and wastewater treatment system. The content of phosphorus in shallow groundwater is also increased by the fertilisers used in the settlement. If too much fertilizers are applied, phosphates are carried into the surface waters with storm runoff and melting snow. Organic phosphates are formed in the biological processes. They contribute to sewage by body waste and food residues present in animal waste.

Farming activities like stock-raising or horticulture are very popular in almost all households in the Dovinė river valley. The bulk of the raised production remains in the settlements, influencing the very high level of phosphorus in the shallow groundwater and water wells. However, no direct sewerage places were detected as they were hidden under the ground or the watertable. Therefore, evaluation of phosphorus load from the sewerage system to the river is very difficult.

Some households and public offices are connected to the municipal water and wastewater treatment system in the Simnas settlement. However, the old technologies and low power of the wastewater treatment do not clean the sewerage properly. The total phosphorus concentration in the sewerage from the municipal wastewater treatment system reaches 2.76 mg P l^{-1}, of organic phosphorus 0.333 mg P l^{-1}, mineral phosphorus 2.43 mg P l^{-1}. These amounts of phosphorus go directly to Lake Simnas. This is an additional source of phosphorus pollution in the Dovinė river. The annual amount of phosphorus (Taminskas et al., 2006) reaching Lake Simnas from the municipal wastewater treatment system is approximately 100 kg.

The highest amount of phosphorus goes to the river from the Simnas fishery ponds in this section. However, there is no water discharge and phosphorus load graphic or recording from these fishery ponds. Therefore, it is very difficult to evaluate their contribution to the pollution. The water is officially released from the ponds one time each two months, but, according to the local inhabitants, this process is very irregular: the biggest part of water is released in several days or even hours. Due to this specificity we could not manage water sampling during the peak flow. However, even during a small discharge of the water, the concentration of the total phosphorus varied from 0.07 to 0.42 mg P l^{-1} (average 0.16 mg P l^{-1}), of mineral phosphorus from 0.03 to 0.05 mg P l^{-1} (average 0.04 mg P l^{-1}), organic phosphorus from 0.03 to 0.39 (average 0.12 mg P l^{-1}) below the fishery ponds (Fig. 4, point 2*). On the other hand, phosphorus concentration increased even four-fold (Fig. 4) below Lake Simnas when releasing the pond and 1–2 months after its release. Phosphorus load from the fishery ponds is about 2020 kg P y^{-1} (Taminskas et al., 2006). Therefore, the high intake of phosphorus from the fishery ponds may be one of the main causes of the extremely high phosphorus load in the section between fishery ponds and Lake Simnas (Fig. 3, point 3).

The concentration of total phosphorus varied from 0.122 to 0.420 mg P l^{-1} below the fishery ponds on 8–18 October 2004. It exceeded 0.110 mg/l at the beginning and at the end of the month. According to the marks left at the river bank, the peak water discharge occurred before the beginning of the measurements. Later the water discharge from the ponds was smaller and irregular.

The amount of phosphorus measured in the river before entering Lake Simnas varied and was very irregular in 2004. However, the same regularities might be observed here and in the upper cross-section of the river: the total amount of phosphorus varied from 0.066 to 0.442 mgP/l^{-1} in October and only from 0.072 to 0.094 mg/l^{-1} in November. The content of phosphorus varied very irregularly and exceeded 0.5 mg/l^{-1} twice (on 29 March and 5 May) at this point in 2005. The first case might be influenced by phosphorus load from the melting snow brought from the Simnas settlement, whereas the second case is influenced by the abundant rainfall. The water discharge from the overfilled Simnas fishery ponds flew directly to the stream.

Different regularities are observed in the water discharged from Lake Simnas. In it, the concentration of total phosphorus ir very high (up to 1.215 mg/l^{-1}) while discharging the Simnas fishery ponds and sometimes after the discharge. The concentration of total phosphorus was the highest in Lake Simnas at the end of March in 2005. Later it varied within 0.044–0.072 mg/l^{-1}.

The main source of phosphorus in Lake Giluitis is the intensive farming and the Simnas settlement sewerage system. About 55% of phosphorus surface inflow is of anthropogenic origin. Phosphorus load with groundwater discharge from the urban area to Lake Giluitis is 8% and with rainfall 15%. About 72% of phosphorus is retained in the lake. The phosphorus (in kg $y^{-}1$) balance equation in Lake Giluitis is:

760 SI + 80 GD + 150 PI – 280 OF = 710 RET.

Phosphorus load from Lake Giluitis to Lake Simnas is only 5% compared to phosphorus load with surface inflow to Lake Simnas. Phosphorus load from the fishery ponds comprises the biggest part (about 39%). The phosphorus (kg $y^{-}1$) balance equation in Lake Simnas as follows:

5160 SI + 170 GD + 160 PI – 3100 OF = 2390 RET.

The limiting biogene was nitrogen when discharging the ponds to Lake Simnas, because the nutrient ratio 1 : 2 was observed in the stream. In principle, the water of Lake Simnas changes each 2 months. Thus, phosphorus content decreases in Lake Simnas till the spring flood, and the ratio of the average annual concentration of phosphorus and nitrogen becomes 1 : 20. Therefore, the peak of the average annual phosphorus concentration is observed above Lake Simnas (Fig. 3, point 3), where the influence of the fishery ponds is enhanced by other sources of pollution. To conclude, Lake Simnas, annually retaining about 980 mg P m^{-2}, could be called a lake of a very high productivity.

The same tendency is also observed in the river section situated between Simnas and Žuvintas lakes. Here,

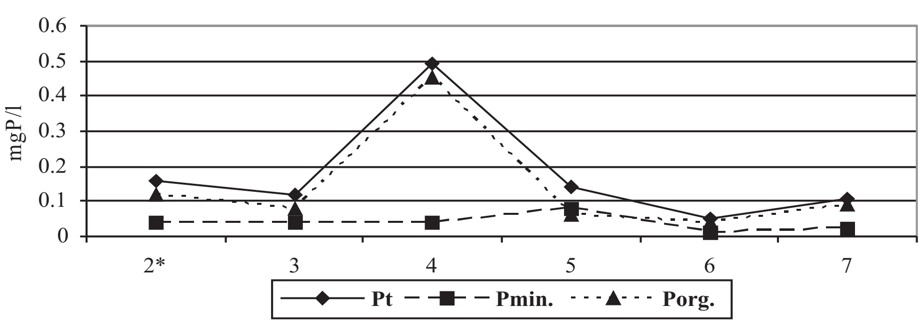

Fig. 4. Phosphorus fluctuation in the longitudinal section in the Dovinė river during 2004: 2* – the Spernia river below Simnas fishery ponds; 3 – above Lake Simnas; 4 – below Lake Simnas; 5 – above Lake Žuvintas; 6 – below Lake Žuvintas; 7 – the Dovinė river near Daukšiai settlement

the maximum level of phosphorus was observed in November 2004. It did not exceed 0.072 mg P l^{-1} in 2005.

The amount of phosphorus was very low and exceeded 0.01mg P l^{-1} only one time (on 10–11 April) in the creek of Lake Žuvintas in 2004. A very low level of phosphorus was observed here in 2005 (up to 0.017 mg P l^{-1}). However, once (on 20 May) it reached 0.265 mg P l^{-1}, probably because of a showery rainfall.

The load of phosphorus from Lake Žuvintas was 2040–3150 kg P y^{-1} in 1999–2005. There was 3980 kg P y^{-1} of phosphorus loaded with the surface inflow, 2160 kg P y^{-1} from the lake and 2520 kg P y^{-1} of phosphorus retained in Lake Žuvintas in 2004–2005. Approximately 34% of phosphorus loaded with the surface inflow is of anthropogenic origin. The phosphorus (kg $y^{-}1$) balance equation in Lake Žuvintas is

3980 SI + 90 GD + 610 PI – 2160 OF = 2520 RET.

The phosphorus level increases in the Dovinė river below Lake Žuvintas. It was twice as high near the Daukšiai settlement as compared with the measurements near Lake Žuvintas in 2004. However, it exceeded 0.1 mg P l^{-1} only two times (on 22 and 25 October 2004) throughout the whole period of sampling. This might be influenced by a higher phosphorus load from the Daukščiai settlement, caused by a storm runoff. The higher amount of phosphorus at this point was noted during a spring flood and after quite a long rainy period (from 5 to 20 May). The Amalva river, called Šlavanta up to Lake Amalvas, enters the Dovinė river in this section. There is an exploited peatland in this river upstream. The Amalvas wetland and the euthropic Lake Amalvas are situated downstream the Amalva river. The water level of Lake Amalvas diminished in the 7th decade of the 20th century. About 85% of phosphorus loaded with the surface inflow is of anthropogenic origin. The phosphorus (kg $y^{-}1$) balance equation in Lake Amalvas is as follows

2750 SI + 40GD + 120 PI – 2430 = 480 RET.

Phosphorus concentration increases after the vegetation period in the mouth of the Dovinė river (Fig. 1, point 12). This frequently coincides with the discharge of the Simnas fishery ponds. Phosphorus load increases with snow melting and after excessive rainfalls.

CONCLUSIONS

The Dovinė river catchment changed insignificantly till the first half of the 20th century, although the bigger part of the catchment had been used for agricultural purposes for a long time. Extensive farming activities, relatively vast unmeliorated territories and the absence of large point pollution sources determined a three times lower phosphorus load on the hydrographic network as compared with the contemporary situation. Nevertheless, rapid euthropication in Lake Žuvintas was observed in the first half of the 20th century. It was influenced by the loss of the forested territories and by intensive melioration in the midstream and downstream of the Dovinė river.

Phosphorus load and retention in the lakes was accelerated by unsustainable farming activities and reconstructions made in the catchment in the 7th and 9th decades of the 20th century, which resulted in a rapid euthropication of all lakes situated in the Dovinė river catchment. The main sources of phosphorus were farming territories and huge stock-raising farms.

The collapse of unsustainable public farming in the last decade of the 20th century influenced the decline of phosphorus load. However, this decline was not as big as expected. Recently, phosphorus loading is very intensive from the Simnas fishery ponds and urban territories without municipal wastewater treatment system.

Annual phosporus load to the hydrographic network of the Dovinė river cathcment is about 15200 kg P y^{-1}, of which 78% is of anthropogenic origin. About 7960 kg P y^{-1} is retained in the five biggest lakes in the catchment: 80 mg m^{-2} in Lake Dusia and the highest amount – 980 mg m^{-2} – in Lake Simnas.

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FOSFORO NUOTĖKIS IR JO SULAIKYMAS HIDROGRAFINIAME TINKLE

Santrauka

Dovinės baseine yra 5 didesni už 100 ha skirtingos trofinės būklės ežerai. Žuvintas – pagrindinis Žuvinto biosferos rezervato ežeras, esantis centrinėje baseino dalyje. Dėl eutrofikacijos sparčiai besiplečiantys plūduriuojančių makrofitų sąžalynai nuolat mažina ežero plotą. Viena pagrindinių makrofitų klestėjimo priežasčių yra didelė biogenų, ypač fosforo prietaka iš baseino. Labai sparti eutrofikacija stebima ir kituose Dovinės baseino ežeruose – Amalve ir Simne. Simno ežero užaugimas makrofitais ypač paspartėjo per pastaruosius tris dešimtmečius. Kiek mažesnė eutrofikacija Giluičio ežere, o Dusios ežere, esančiame baseino aukštupyje, esminių eutrofikacijos padarinių nenustatyta.

Šio darbo tikslas – įvertinti pagrindinius Dovinės baseino fosforo šaltinius, jo sulaikymą baseino ežeruose bei išnešimą iš baseino.

Iki XX a. iš mažai paveikto Dovinės baseino vidurio fosforo nuotėkis buvo apie 0,07 kg P ha^{-1}. Tačiau ir šiuo laikotarpiu jau didesnė baseino dalis buvo bemiškė ir naudojama ekstensyviam žemės ūkiui. Didesnių taškinės taršos šaltinių šiuo laikotarpiu baseine nebuvo, o švariausiame baseino ežere (Dusia) bendrojo fosforo koncentracija buvo 0,01–0,05 mg P l^{-1}. Nedaug didesnė fosforo koncentracija buvo ir kituose baseino ežeruose. XX a. 6–9-e dešimtmečiuose Dovinės baseino nedarnus žemės ūkis vidutinį metinį fosforo nuotėkį iš agrarinių teritorijų padidino iki 0,18 kg P ha^{-1}. Net švariausiame baseino ežere bendrojo fosforo kiekis kai kuriais atvejais siekdavo iki 0,156 mg P l^{-1}. 1999–2005 m. dėl aplinkosauginių priemonių ir sumažėjusio žemės ūkio intensyvumo, fosforo prietaka iš agrarinių teritorijų sumažėjo iki 0,05–0,135 kg P ha^{-1}. Vidutinė metinė fosforo koncentracija baseino ežeruose buvo nuo 0,036–0,039 mg P l^{-1} (švariausias baseino ežeras – Dusia) iki 0,044–1,215 mg P l^{-1} (labiausiai teršiamas baseino ežeras – Simnas).

Šiandien, be nuotėkio iš agrarinių teritorijų, vis didesnę įtaką fosforo nuotėkiui turi jo prietaka su užterštu požeminiu urbanizuotų teritorijų vandeniu ir taškiniai taršos šaltiniai. Dovinės baseine daugelis esančių gyvenamųjų namų neturi nuotekų valymo įrenginių ir neprijungti prie centralizuotų nuotekų surinkimo ir valymo sistemų. Nuotekos per slepiamus išleistuvus patenka tiesiai į upelius ir ežerus, arba iš nesandarių septikų filtruojasi į požeminį vandenį. Todėl Dovinės slėnio šachtiniuose šuliniuose bendrojo fosforo koncentracija kito nuo 0,094 iki 3,9 mg P l^{-1}. Be išsklaidytos taršos, Dovinės baseine yra bent vienas ypač didelį poveikį darantis taškinis taršos šaltinis – tai Simno žuvininkystės tvenkiniai, fosforo prietaka iš žuvininkystės tvenkinių gali būti apie 2020 kg P m.$^{-1}$.

Dovinės baseine per metus į hidrografinį tinklą patenka apie 15200 kg P m.$^{-1}$, tarp jų apie 78% yra antropogeninės kilmės fosforas. Apie 7960 kg P m.$^{-1}$ sulaikoma 5 didžiuosiuose baseino ežeruose: mažiausiai – Dusios ežere 80 mg m^{-2}, daugiausiai – Simno ežere 980 mg m^{-2}.

Raktažodžiai: Dovinės upės baseinas, Žuvinto biosferos draustinis, tarša fosforu, fosforo kaupimasis, eutrofikacija