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Analytical Survey of the Pilot Area Intended for the Project Interreg Baltic Sea Region Programme 2014-2020

WATERDRIVE

Luga District, Leningrad Region

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Introduction

Agricultural production intensification increases impact on the environment. The negative effect on the environmental situation in border areas may be provided by underdeveloped infrastructure and underused innovative technologies linked to disposal of animal husbandry and poultry farming waste. Waterbody pollution is of major concern, as this area is a part of the Baltic Sea drainage basin, and thus, it is subject to the Russian environmental legislation, as well as to the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area which pays particular attention to measures aimed at reduction of biogenic element delivery to waterbodies, including those coming from agricultural enterprises.

The goal of the WATERDRIVE project is to implement new intellectual methods of managing water resources across agricultural landscapes in order to reduce biogenic impact on waterbodies by 30 to 50 %.

Luga district was selected for this project on purpose. Previous studies discovered that Leningrad provides has significant biogenic impact which concerns interests of all the Baltic Sea countries. The main flow of biogenic substances is generated onshore by nitrogen and phosphorus combinations (eutrophication) resulting from agricultural activity and public utilities. A large number of agricultural and industrial enterprises are located in Luga region, near the Luga River and its tributaries. Thus, environmental risks are highly probable. A range of unique natural landmarks, rare species of plants and animals, archaeological sites and specific climate conditions make this district attractive for tourism and research. Thus, ecological recovery of the Upper Poluzhye is an important and relevant task (figure 1).

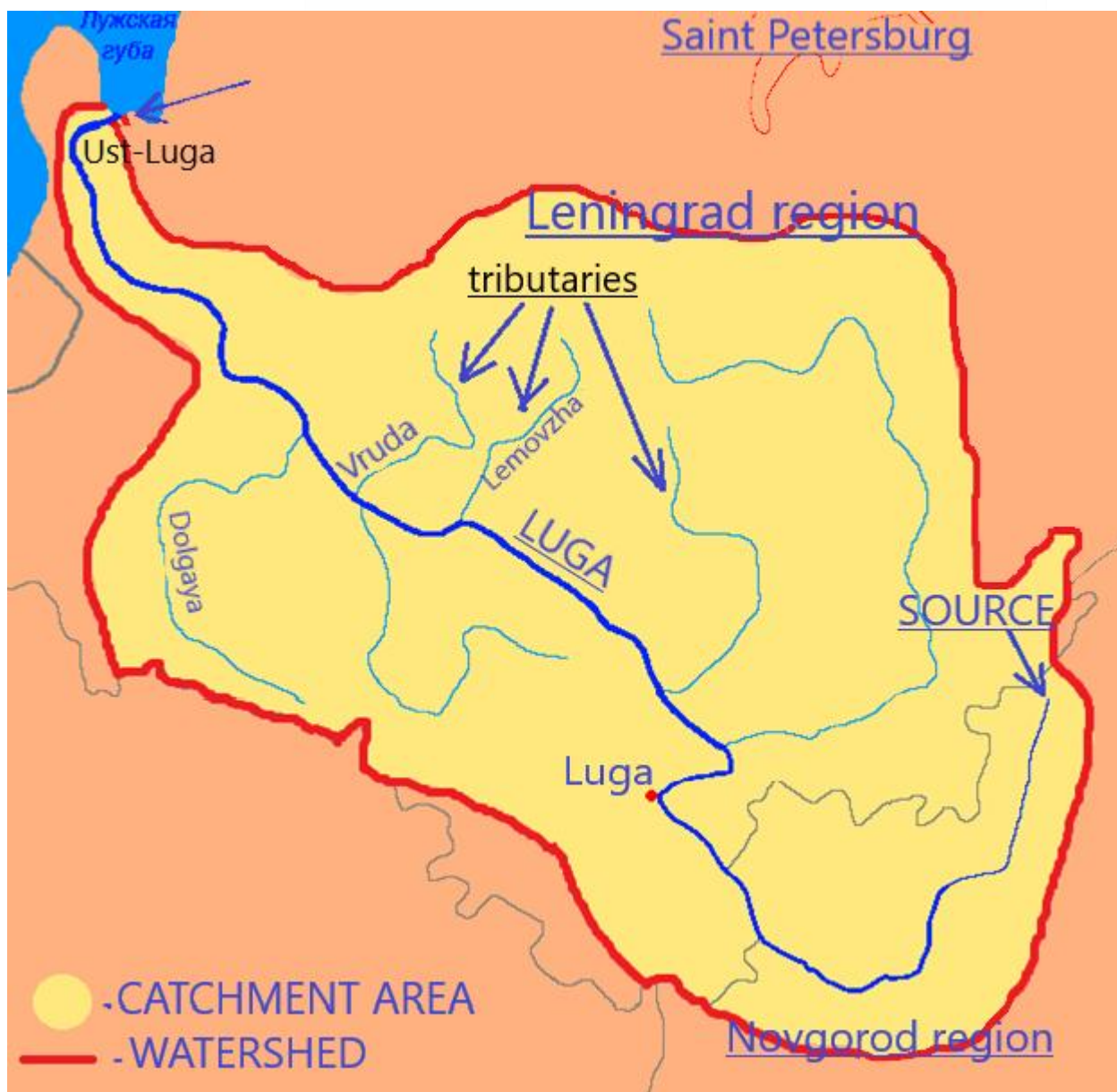


Figure 1. Watershed of the Luga River with its Tributaries [1]

1. Priorities in Ensuring Environmental Safety of Agricultural Enterprises in Luga District

Today, agricultural sector rapidly develops to fulfil the decrees of the Government of the Russian Federation. Such development is directly linked to the Russian environmental strategy aimed at ensuring country's food security.

New animal husbandry facilities are being built and the existing ones are building up their capacity in accordance with their focus and production concentration. This helps to increase labour efficiency and to decrease product cost price. Meanwhile,

some issues related to using immense amount of produced manure and droppings.

Luga district is one of the leaders in animal husbandry in Leningrad region. Considering that the whole district makes a part of the Baltic Sea drainage basin, major attention should be paid to manure and droppings processing and use.

Institute for Engineering and Environmental Problems in Agricultural Production – Branch of the Federal State Budgetary Scientific Institution “Federal Scientific Agroengineering Center VIM” (IEEP – Branch of FSAC VIM) carried out studies which demonstrated that the most developed segment is animal husbandry.

1.1 Basic Data

The Leningrad Region Committee on Agriculture and Fisheries provided its assistance in preparing basic data covering the condition of animal husbandry and plant growing enterprises operating in Luga district; the data were also based on questionnaires filled in by agricultural companies.

The following information was requested to carry out environmental assessment of agricultural enterprises operating in Luga district of Leningrad region:

- company type (plant growing, animal husbandry, poultry farming, combined);
- field of activity (for pig farming companies: fattening, reproduction, full cycle; for poultry farming companies: egg and broiler farming; for cattle facilities: dairy or fattening sector);
- animal/poultry livestock in a company;
- company’s cultivated area intended for crops (by cultivated crops), ha;
- consumption of mineral fertilisers, t/year;
- consumption of organic fertilisers, t/year;
- organic fertiliser delivery to other enterprises, t/year.

On-site inspections of standard agricultural enterprises, official statistics and Leningrad region satellite-aided analysis were used within the basic data processing.

1.2 Data Analysis

1.2.2 Data Analysis for Leningrad Region's Luga District

Leningrad Region's Luga District includes 14 municipalities with 16 agricultural enterprises, which include 10 cattle breeding facilities, 2 pig farming facilities and 4 plant growing facilities (figure 2). All animal husbandry companies located in Luga district have their own fields where they grow plants, thus, they can fully use all generated organic fertilisers – this makes a particular advantage of district's agricultural production comparing to other districts in the region.

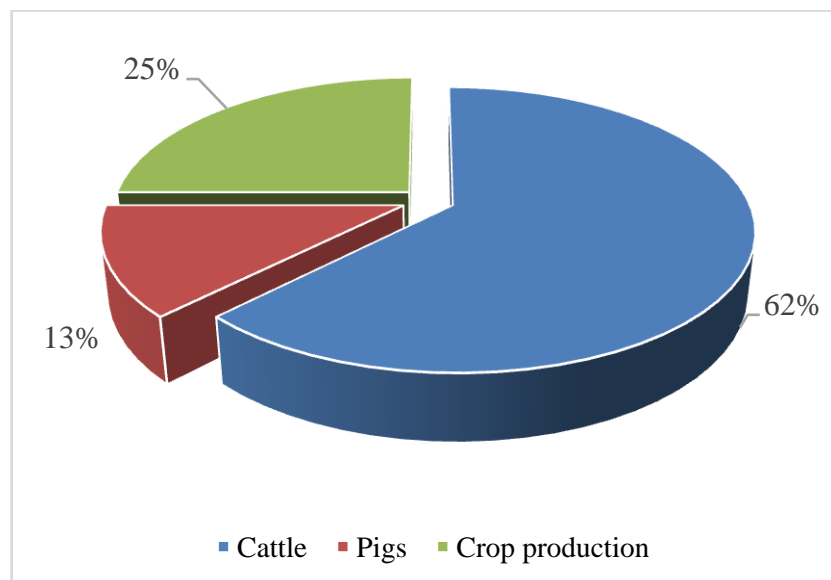


Figure 2. Agricultural Enterprises in Luga District, Leningrad Region

Luga district hosts 12 animal husbandry companies with the livestock over 48,000 animals: cattle accounts for 19,515 animals and pigs account for 29,200 (figure 3).

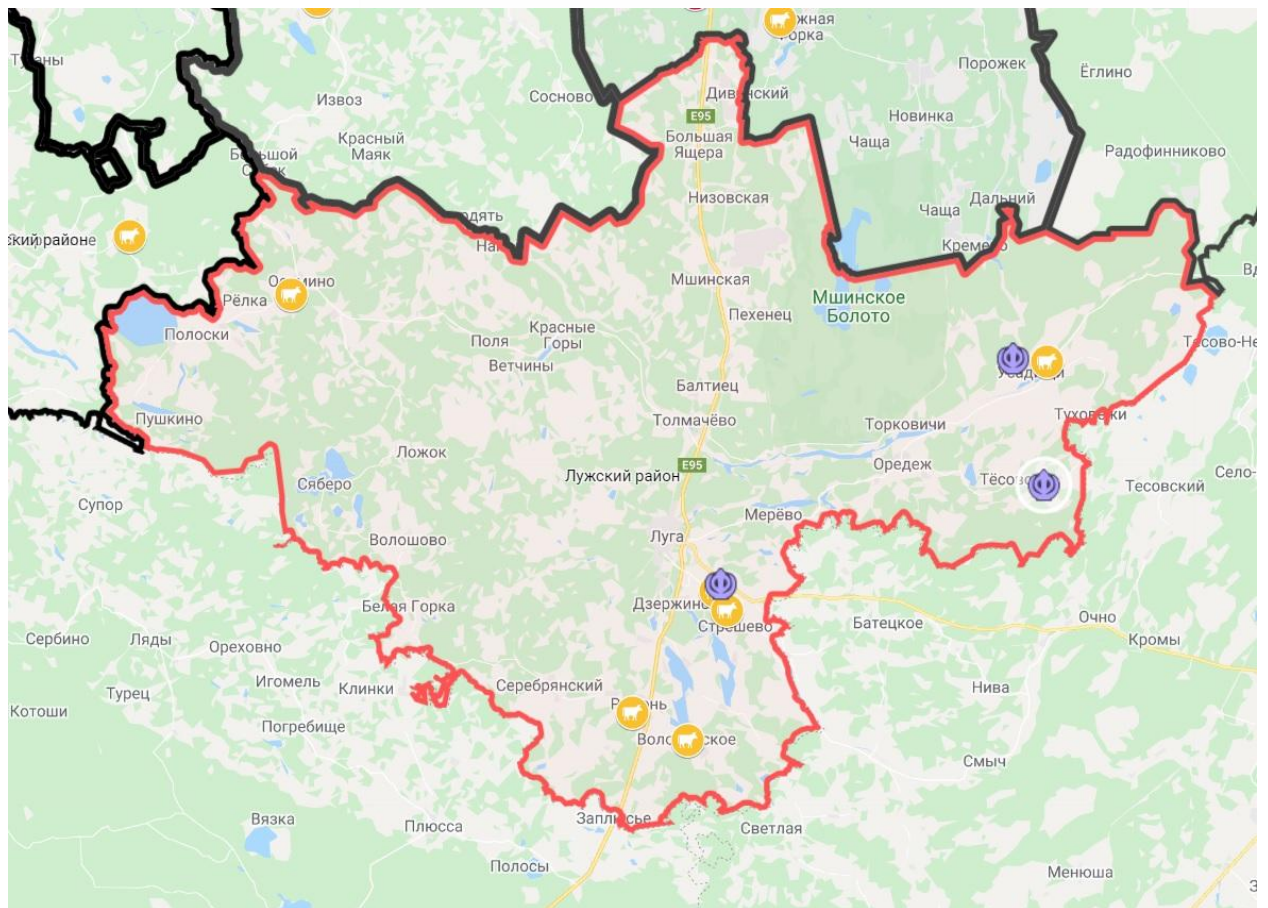


Figure 3. Large Animal Husbandry Enterprises in Luga District

Cattle

10 agricultural companies breeding cattle are located in Luga district of Leningrad region.

Luga district has intensive cattle breeding, which means that over 60% of animal husbandry facilities have over 1,000 animals (figure 4) at a time. Meanwhile, one company deals with calf fattening and holds 10,000 animals simultaneously, which creates some certain difficulties with manure transportation for long distances, as large livestock is concentrated within a limited area.

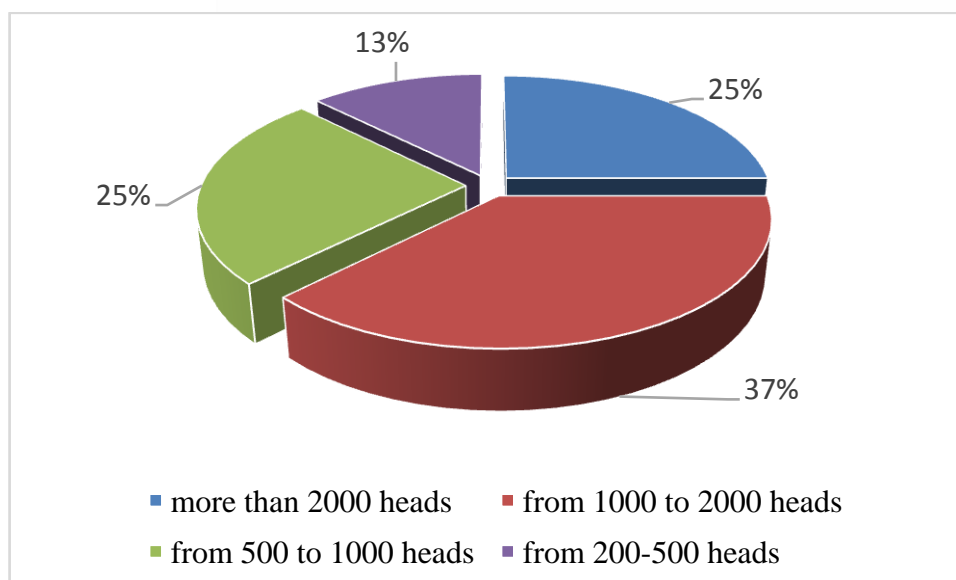


Figure 4. Cattle Facilities by Livestock in Leningrad Region

The livestock of 3 enterprises accounts for 1,000 to 2,000, and the livestock of 2 enterprises exceeds 2,000 at any time. There are 2 enterprises with up to 200 animals, 2 enterprises with 500 to 1,000 animals and 1 with 200 to 500 animals.

Pig Farming

Luga district has two pig farming enterprises. One holds over 19,000 pigs at a time, another one holds 10,000 pigs at any time.

Plant Growing

The main cultivated crops in Luga district include perennial and annual herbs and grain legumes. The cultivated area (as of the end of 2019) is over 24000 ha, which makes 11.6% of the Leningrad region's cultivated area [2]. The sod-podzolic automorphic soils prevail in agricultural land, however, stages of cultivation vary across as half of such land. Meanwhile, 1.0 hydrothermic coefficient of soil moisture content creates the conditions for cultivated land overwatering. Thus, land reclamation with various technology readiness levels is arranged for almost all fields.

During the 2020 on-site studies of reclamation ditches draining water to the Luga River, it was discovered that fields using large amounts of organic fertilisers (point

5) deliver more biogenic elements (ammonium nitrogen as an example) (figure 5-6).



Figure 5. Water Sampling in the Reclamation Ditch

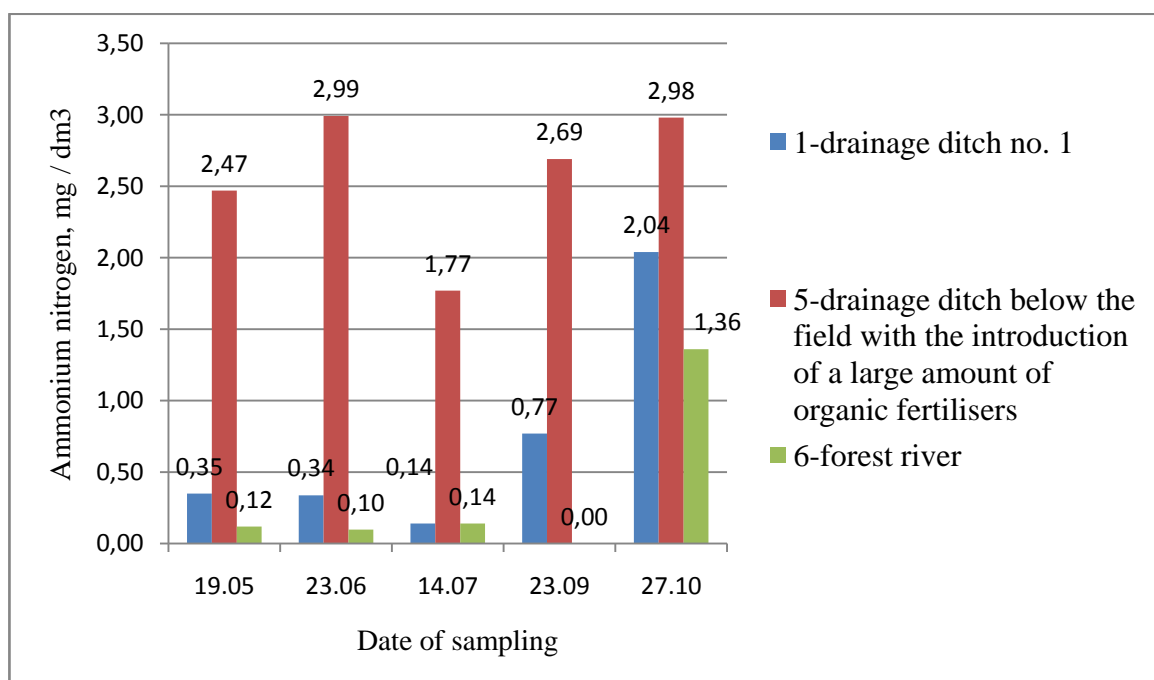


Figure 6. Results of Water Sampling in the Reclamation Ditch Comparing to Samples Made in a Stream Not Affected by Agricultural Production (Point 6)

The mentioned facts show the need to use organic fertilisers to improve soil fertility, as well as point out importance of water reclamation systems and agricultural waste water treatment.

1.3 Organic Waste Generation Analysis

Environmental assessment of agricultural enterprises involved analysis of manure generation and accumulation in Luga district, as well as its possible use as organic fertiliser for district's agricultural lands. Thus, 665,322 t/year of manure are generated in Luga district (as of late 2018). The area of agricultural lands is 24000 ha.

Table 1 shows nutrient content in animal faeces in accordance with the Russian guidance documents.

Table 1. Nutrient Content in Various Animal Faeces

Content of Cattle Faeces in Dry Matter, %	
Total nitrogen (N)	3.2
Phosphorous (P₂O₅)	1.8
Potassium, (K₂O)	5.0

Content of Cattle Faeces in Dry Matter, %	
Total nitrogen (N)	6
Phosphorous (P₂O₅)	3.2
Potassium, (K₂O)	2.5

All generated manure/droppings contain 1,339 tons of N (primary nutrient). These nutrients can fertilise at least 7890 ha of agricultural lands.

Mass of nitrogen generated in organic fertiliser was calculated to identify risks in case of biogenic impact provided by animal husbandry facilities. Existing guidelines of HELCOM [3, 4] (170 kg/ha of nitrogen) and RD-APK 1.10.15.02-17 «Guidelines for the Process Design of Systems Intended for Manure and Droppings Removal and Preparation for Use» were used to calculate the maximum rate of application for each type of organic fertiliser based on cattle and swine manure. The potential possibility to fully use manure in Luga district was assessed (Table 2) based on

calculated rate of application (tons per hectare), the total area of cultivated land and cultivated crops in each district.

Table 2. The potential possibility to fully use manure in Luga district

Nº	District of Leningrad region	Agricultural land area, ha	Amount of total nitrogen possible to be received to the agricultural land, t/year	Total nitrogen generated in fertiliser, t/year	Balance (can additionally receive total nitrogen), t/year
1	Luga district	24690	4197	1339	+2858

Nitrogen mass in an organic fertiliser was corrected comparing to the nitrogen mass in original manure based on nitrogen loss during manure processing into organic fertiliser.

According to calculations for Luga district, it has the potential for application of additional nitrogen with organic fertiliser at agricultural lands.

The Baltic Sea countries consider 1.5 livestock units per 1 ha of agricultural land conditionally safe parameter of livestock density [5, 6]. When the values of 1.5 – 1.7 livestock units per 1 ha are exceeded, excessive nutrients may accumulate in soil and, thus, pollutant emission to atmosphere may also increase.

Analysis showed that the average livestock density index per cultivated land unit in Luga district is 1.0 livestock unit/ha, which means that Luga district does not exceed the recommended level. Livestock was converted into livestock units based on Eurostat guidelines (table 3) [7]

Table 3. Livestock conversion into Livestock Units, LSU

Animal	Sex and Age Group	Coefficient
Cattle	up to 1 year old	0.4
	1 to 2 year old	0.7
	Bull calves: 2-year old and more	1
	Heifer calves: 2-year old and more	0.8

Swines	Dairy cow	1
	Other cows: 2-year old and more	0.8
	Pigs with less than 20 kg	0.027
	Sows over 50 kg	0.5
	Other swines	0.3

1.4 Pilot Area

Mentioned facts confirm the importance of efficient and safe use of organic fertilisers. The pilot area was selected to practice environmental-friendly ways of dealing with organics.

Luga's district pilot area is 3,100 ha which hosts pig farming facility, agricultural and municipal lands. This area was selected on purpose, as two large-scale animal husbandry enterprises are located nearby: the pig farming facility and the cattle growing farm.

The area is located near the source of one of the Luga River's tributaries, thus, it is vital to ensure that only a minimum volume of biogenic elements come from agricultural and municipal lands.

Today the pig farming facility's livestock account for 10,000 units at any time. As it has been mentioned, soils in Luga district lack nutrients to grow crops, thus, the enterprise brings additional fertilisers based on poultry droppings from other districts of the region to maintain soil fertility.

Experts of the IEEP – Branch of FSAC VIM – prepared their proposals on differentiated application of organic fertiliser based on the field condition analysis, which included nutrient content, slopes, distance to waterbodies for each unit plot (figure 7).

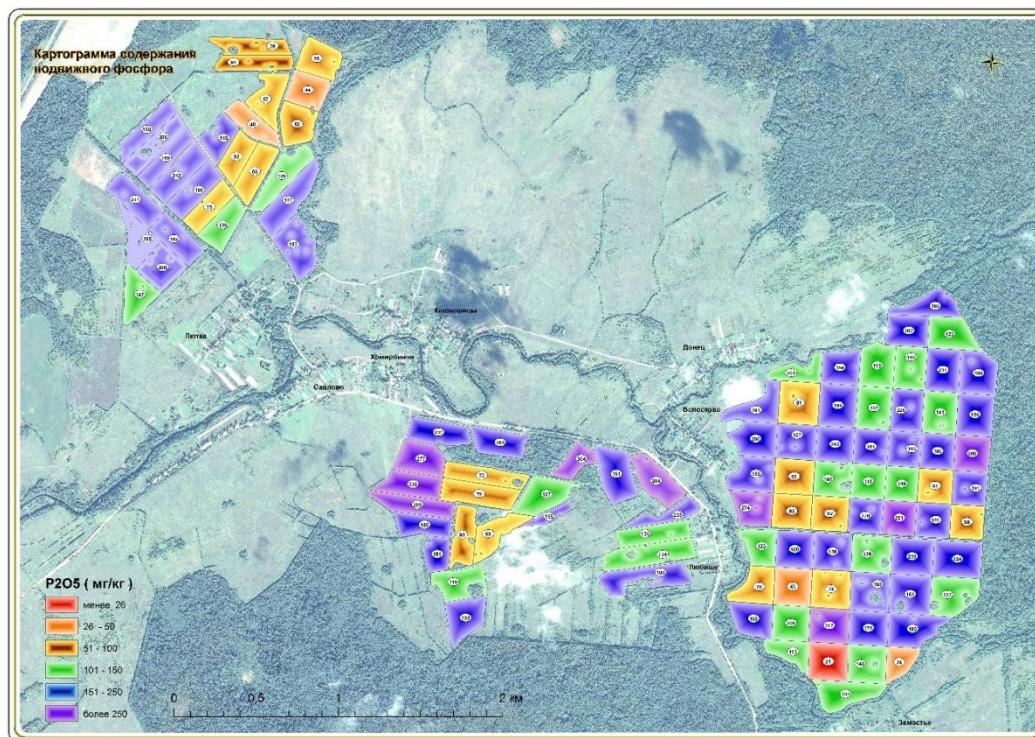


Figure 7. Chart of Mobile Phosphorus in the Pilot Area

It is planned to increase the livestock in the area up to 44,000 pigs by 2028. Thus, the pilot enterprise is of paramount importance, as it is the basis for eliminating the risks of nutrient emission from agricultural lands into waterbodies. The next stage will include drafting proposals on implementing water preservation methods and technologies.

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