

**ASSESSMENT OF THE INTEGRAL INDUSTRIAL IMPACT
ON THE ENVIRONMENT IN THE LENA RIVER BASIN**

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In this article we evaluate for the first time an integral industrial impact on the environment under its negative and positive conditions of development. Our research took place in the Republic of Sakha (Yakutia), in the basin of the Lena River. It was conducted in 2 stages: 1) under the negative industrial impact on the environment, 2) under the positive impact on the environment.

Industrial impact was evaluated using a methodology we have developed in our previous studies. It allowed us to take into account the multifactority of multidimensional indicators that characterize the impact on the studied areas, including the Lena Basin.

The approach presented in our research is based on a simple arithmetic operation, which combines all multidimensional characteristics of the impact in our calculations, and brings them to dimensionless values to determine the degree of their either negative or positive impact on the environment.

The research was carried out in 25 districts of Sakha, all located in the basin of the Lena River. We analyzed 53 negative indicators (combined into 8 groups) and 8 positive indicators (combined into 3 groups) showing the state of various environmental components. Each indicator was assigned a degree of industrial impact on a 5-point scale; each group was also assigned a degree of the total industrial impact on the environment on a 5-point scale. Then we evaluated the total impact within each group, and compiled 11 maps.

Keywords: environment, industrial impact, water resources, ecological, economic and social aspects of influence, negative and positive impact on the environment.

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For the first time we estimated the integral industrial load under different conditions of development of both negative and positive industrial impacts on the environment. This research was carried out in the Republic of Sakha (Yakutia), in the Lena River basin, and consisted of two stages: Stage I was conducted under the negative industrial impact on the environment, while Stage II was conducted under the positive impact.

We assessed the impact of industrial load on the environment according to our own methodology that was developed in our earlier works (Belousova et al., 2019; Belousova, Rudenko, 2020, 2021). It allows us to take into account the multifactoriality of multidimensional indicators that characterize the load on the studied regions, including the Lena River basin.

The approach presented in this article is based on a simple arithmetic action that combines all multidimensional characteristics of environmental impact and brings them to dimensionless values in order to then establish the degree of their either negative or positive impact.

Materials and Methods

For 25 districts of the Sakha Republic (Fig. 1), located in the Lena River basin, we analyzed 53 negative indicators of the condition of various environmental components (State report ..., 2020;

Statistical yearbook ..., 2021; Database ..., 2024). These indicators were combined into 8 groups. Each indicator was assigned a level of industrial load on a 5-point scale. Each group of indicators was assigned a level of intensity of the total industrial load on the environment on a 5-point scale as well; additionally, the total load within each group was estimated and showed on 8 maps further below.

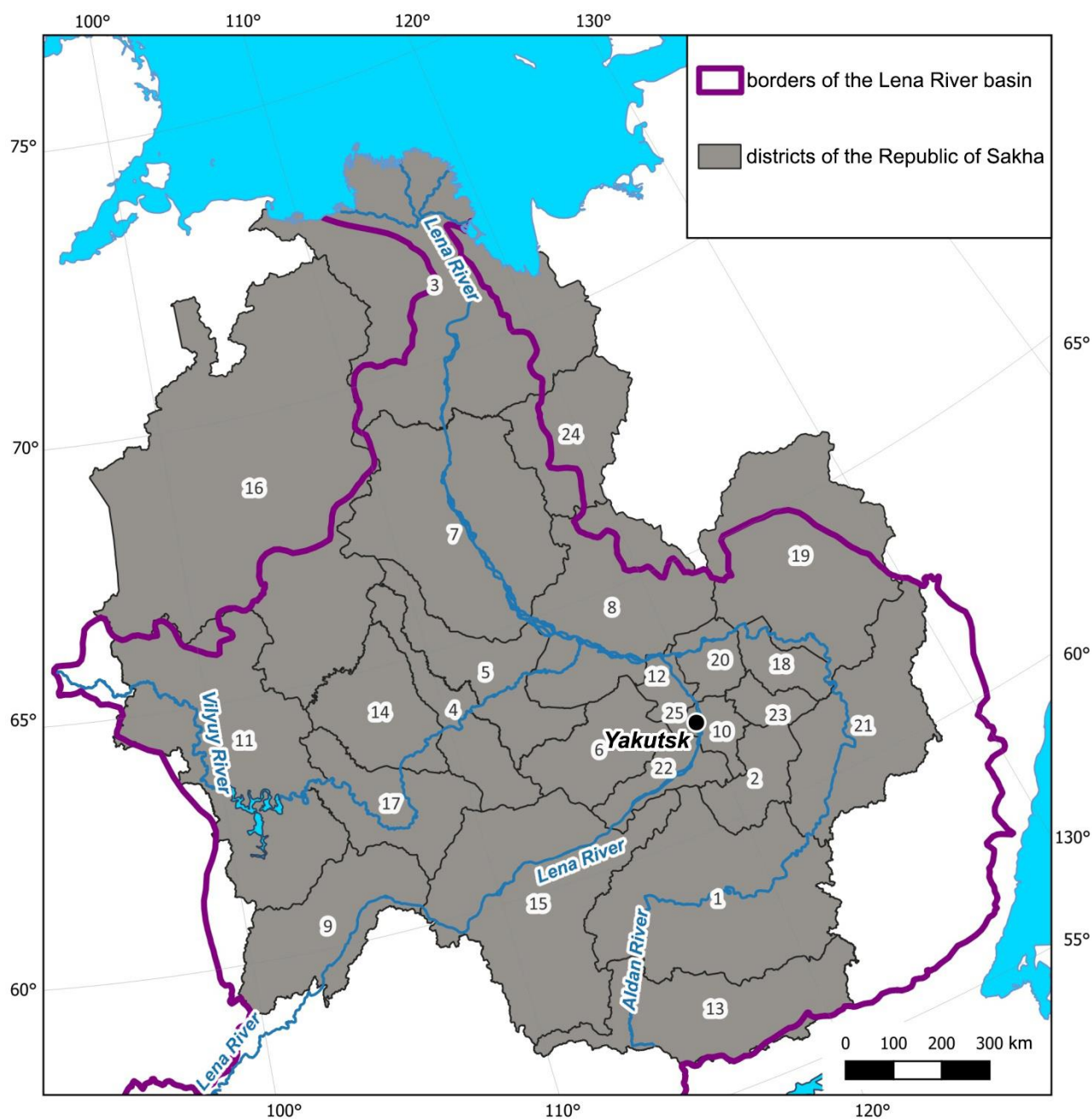


Fig. 1. Administrative division of the Republic of Sakha (Yakutia) in the Lena basin. *Legend.* Districts: 1 – Aldansky, 2 – Amginsky, 3 – Bulunsky, 4 – Verkhnevilyuysky, 5 – Vilyuysky, 6 – Gorny, 7 – Zhigansky, 8 – Kobyaysky, 9 – Lensky, 10 – Megino-Kangalassky, 11 – Mirninsky, 12 – Namsky, 13 – Neryungrinsky, 14 – Nyurbinsky, 15 – Olenyoksky, 16 – Olenyoksky, 17 – Suntarsky, 18 – Tattinsky, 19 – Tomponsky, 20 – Ust-Aldansky, 21 – Ust-Maysky, 22 – Khangalassky, 23 – Churapchinsky, 24 – Eveno-Bytantaysky, 25 – Yakutsk (including an urban locality Zhatay).

Indicators of industrial load with negative impact on the environment were assessed by their groups: I – condition of atmospheric air, II – condition of water resources, III – structure of land use, IV – structure of livestock, V – socio-ecological factors, VI – ecological-economic factors, VII – socio-economic and ecological factors, VIII – radioactive fallout from the atmosphere.

I. Condition of Atmospheric Air (4)¹ (Appendix Table 1):

- 1) Pollutant emissions from the stationary sources (thousand tons; *Column 3*);
- 2) Volume of atmospheric emissions (% of the total emissions in the Republic; *Column 4*);
- 3) Polluting enterprises (units; *Column 5*);
- 4) Stationary sources of pollution (units; *Column 6*).

Total industrial load of this group of indicators (Column 7): 1 – 4-7 (low), 2 – 8-10 (medium), 3 – 11-13 (high), 4 – 14-16 (very high), 5 – higher than 16 (extremely high).

This group's low impact on the state of atmospheric air was recorded in the under-populated districts, such as Bulunsky, Verkhnevilyuysky, Gorny, Zhigansky, Namsky, Olenyoksky, Churapchinsky and Eveno-Bytantaysky (Fig. 2); extremely high impact was recorded in Lensky, Mirninsky and Neryungrinsky districts; very high – in Yakutsk and Aldansky District. Other districts were under either medium or high impact.

II. Condition of Water Resources (7) (Appendix Table 2):

- 1) Water sampling from the natural sources (million m³; *Column 3*);
- 2) Wastewater discharge (million m³; *Column 4*);
- 3/4) Water usage (million m³): 3 – water intake from the natural sources for further usage (*Column 5*), 4 – water discharge into the surface water bodies (*Column 6*);
- 5/6) Structure of fresh water usage (million m³): 5 – manufacturing needs (*Column 8*), 6 – agricultural supply and irrigation (*Column 9*).

Total industrial load of this group (Column 10): 1 – 3-12 (low), 2 – 13-17 (medium), 3 – 18-22 (high), 4 – 23-28 (very high), 5 – higher than 28 (extremely high).

The negative impact of the industrial load on the water resources was low and medium in the most districts of Sakha (Fig. 3). High impact was recorded in the Aldansky, Lensky and Ust-Maysky districts; very high – in Megino-Kangalassky District; extremely high – in Mirninsky and Neryungrinsky districts, as well as in Yakutsk Urban District.

III. Land Use Structure (10) (Appendix Table 3):

- 1-4) Distribution of agricultural lands as of January 1, 2021 (%): 1 – arable lands (*Column 3*), 2 – hay fields (*Column 4*), 3 – pastures (*Column 5*), 4 – total of the entire district's territory (*Column 6*);
- 5-7) Cultivated area (% of the total arable area): 5 – grain (*Column 7*), 6 – potato (*Column 8*), 7 – hardy vegetables (*Column 9*);
- 8-10) Crop yield (tons per 1 ha of arable land): 8 – grain (*Column 10*), 9 – potato (*Column 11*), 10 – hardy vegetables (*Column 12*).

Total industrial load of this group (Column 13): 1 – 9-17 (low), 2 – 18-25 (medium), 3 – 26-32 (high), 4 – 33-40 (very high), 5 – higher than 40 (extremely high).

The structure of land use had a low impact on the environment of 6 districts of Sakha (Bulunsky, Gorny, Zhigansky, Olenyoksky, Tomponsky and Eveno-Bytantaysky; Fig. 4). The main negative impact was caused by numerous deer pastures. In 6 other districts (Amginsky, Kobyaysky, Megino-Kangalassky, Neryungrinsky, Ust-Aldansky, Khangalassky) the negative impact was high, and very high in Yakutsk. Other districts were under medium impact.

IV. Structure of Livestock (7) (Appendix Table 4):

- 1-5) Density of livestock (number of heads per 100 ha of pastures): 1 – cattle (*Column 3*), 2 – cows (*Column 4*), 3 – pigs (*Column 5*), 4 – horses (*Column 6*), 5 – reindeer (*Column 7*);
- 6) Number of birds (thousand heads; *Column 8*);

¹ Hereinafter the brackets show a number of indicators within a group.

7) Number of sheep, goats and rabbits (heads; *Column 9*).

Total industrial load of this group (Column 10): 1 – 7-12 (low), 2 – 13-17 (medium), 3 – 18-22 (high), 4 – 23-28 (very high), 5 – higher than 28 (extremely high).

The negative impact of the structure of livestock was insignificant on the environment of Yakutia, measuring from low to medium in most districts (Fig. 5). It was high in 5 districts (Aldansky, Vilyuysky, Lensky, Megino-Kangalassky, Nyurbinsky), but extremely high in Neryungrinsky District.

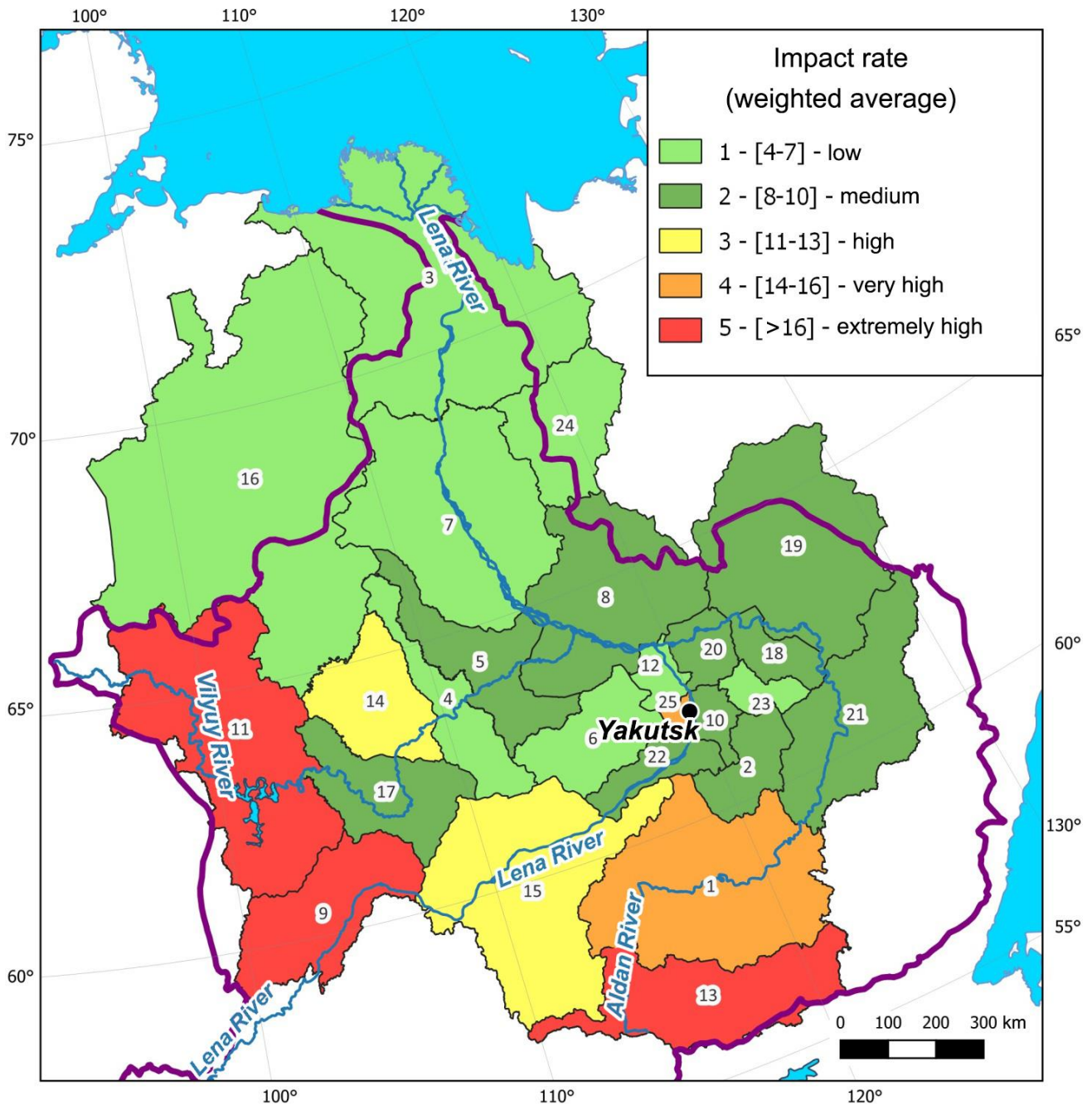


Fig. 2. Overview map of the degree of negative industrial impact on the environment in the Lena basin: air condition.

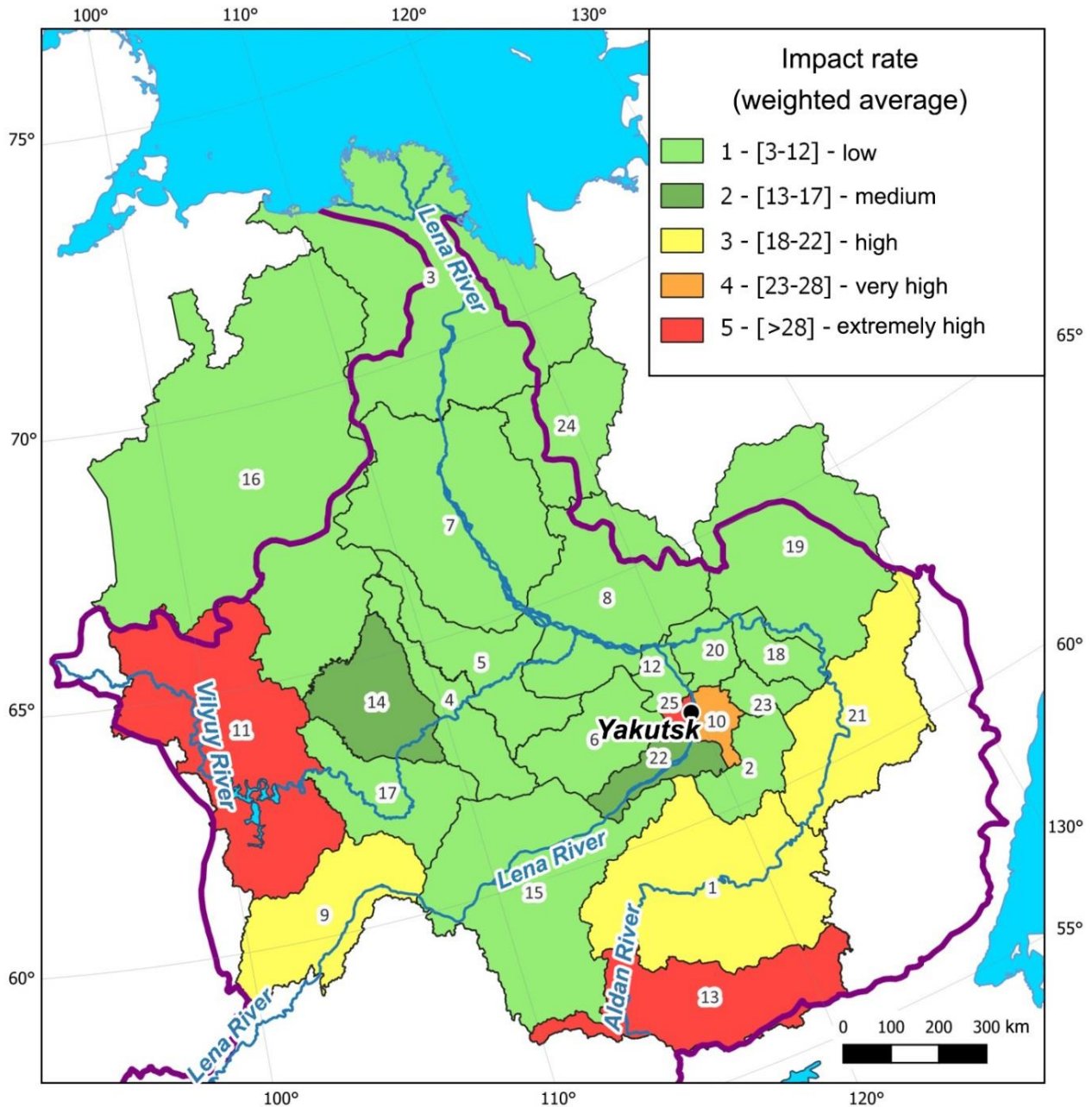


Fig. 3. Overview map of the degree of negative industrial impact on the environment in the Lena basin: condition of water resources.

V. Socio-Ecological Factors (4) (Appendix Table 5).

- 1) Population density (ind./km²; Column 3);
- 2) City population (%; Column 4);
- 3) Natural population growth (per 1000 ind.; Column 5);
- 4) Net migration (per 1000 ind.; Column 6).

Total industrial load of this group (Column 7): 1 – 4-7 (low), 2 – 8-10 (medium), 3 – 11-13 (high), 4 – 14-16 (very high), 5 – higher than 16 (extremely high).

Demographic indicators were evaluated by their negative impact on the environment; therefore, the areas with population decline were marked as favorable ones. Low and medium negative impact of this group on the environment was observed virtually everywhere in the region (Fig. 6),

being high only in 5 districts (Lensky, Megino-Kangalassky, Mirninsky, Neryungrinsky, Khangalassky), and, naturally, extremely high in Yakutsk.

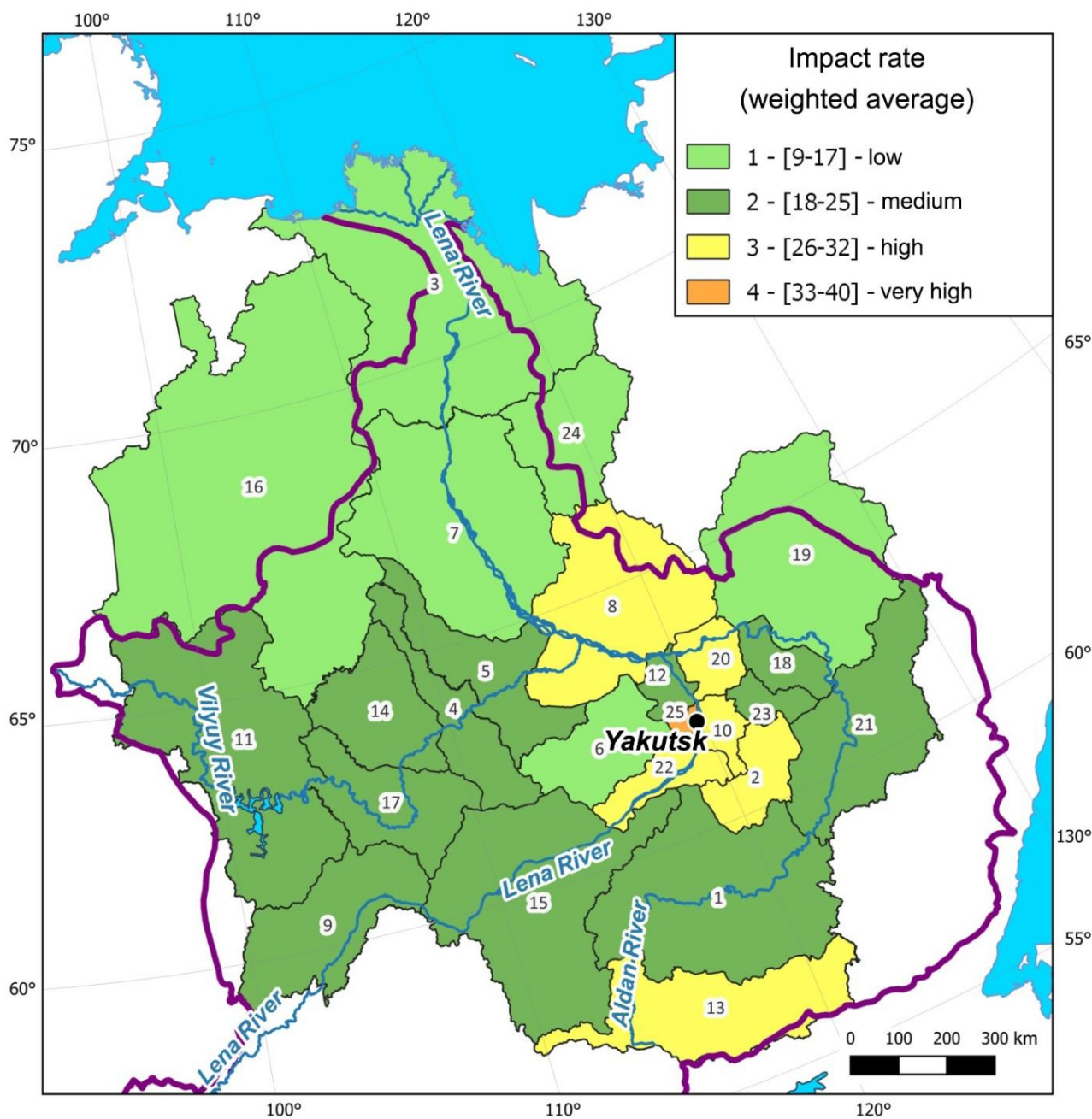


Fig. 4. Overview map of the degree of negative industrial impact on the environment in the Lena basin: land use structure.

VI. Ecological-Economic Factors (8) (Appendix Table 6):

1-3) Ecological fees added to the municipal budget (thousand rubles): 1 – fees for negative impact on environment (*Column 3*), 2 – fines and lawsuits fees added to the budget of the municipal divisions and municipal districts (*Column 4*), 3 – paid to the budget of the municipal divisions and districts after for the negative environmental impact (*Column 5*);

4-6) Current operating costs of nature protection (million rubles): 4 – costs of catchment and

purification of wastewater (*Column 6*), 5 – costs of waste treatment (*Column 7*), 6 – costs of land and natural water rehabilitation and protection (*Column 8*);

7) Current operating costs of environment protection, including costs of nature protecting services (thousand rubles; *Column 9*);

8) Removal of solid household waste per year (thousand m³; *Column 10*).

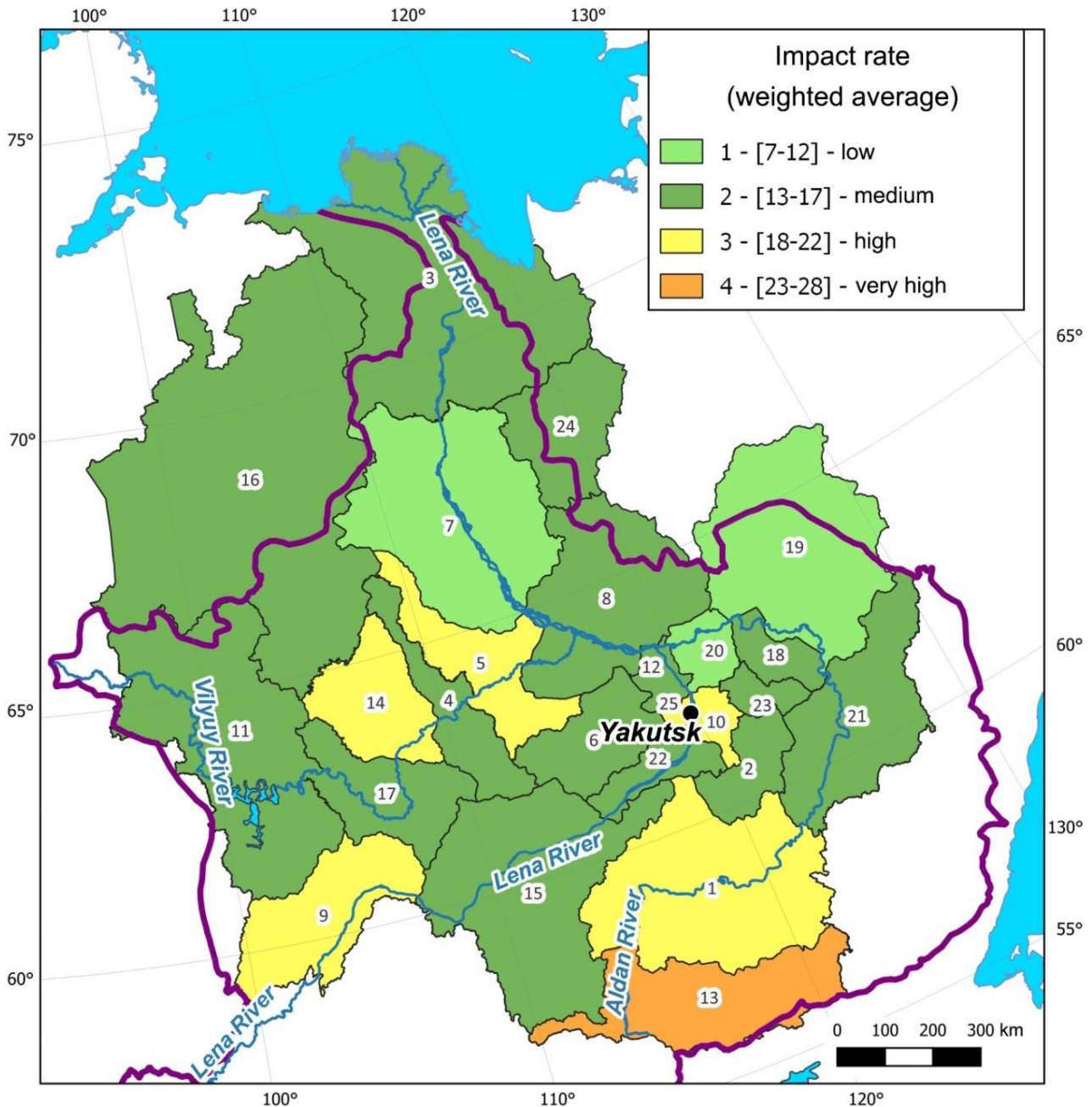


Fig. 5. Overview map of the degree of negative industrial impact on the environment in the Lena basin: structure of livestock.

Total industrial load of this group (*Column 11*): 1 – 4-14 (low), 2 – 15-20 (medium), 3 – 21-26 (high), 4 – 27-32 (very high), 5 – higher than 32 (extremely high).

The negative impact of ecological-economic factors on the environment was mostly low and

medium (Fig. 7). In Aldansky and Nyurbinsky districts it was high; in Mirninsky and Neryungrinsky districts, as well as in Yakutsk Urban District it was very high. Lensky District was under extremely high industrial load.

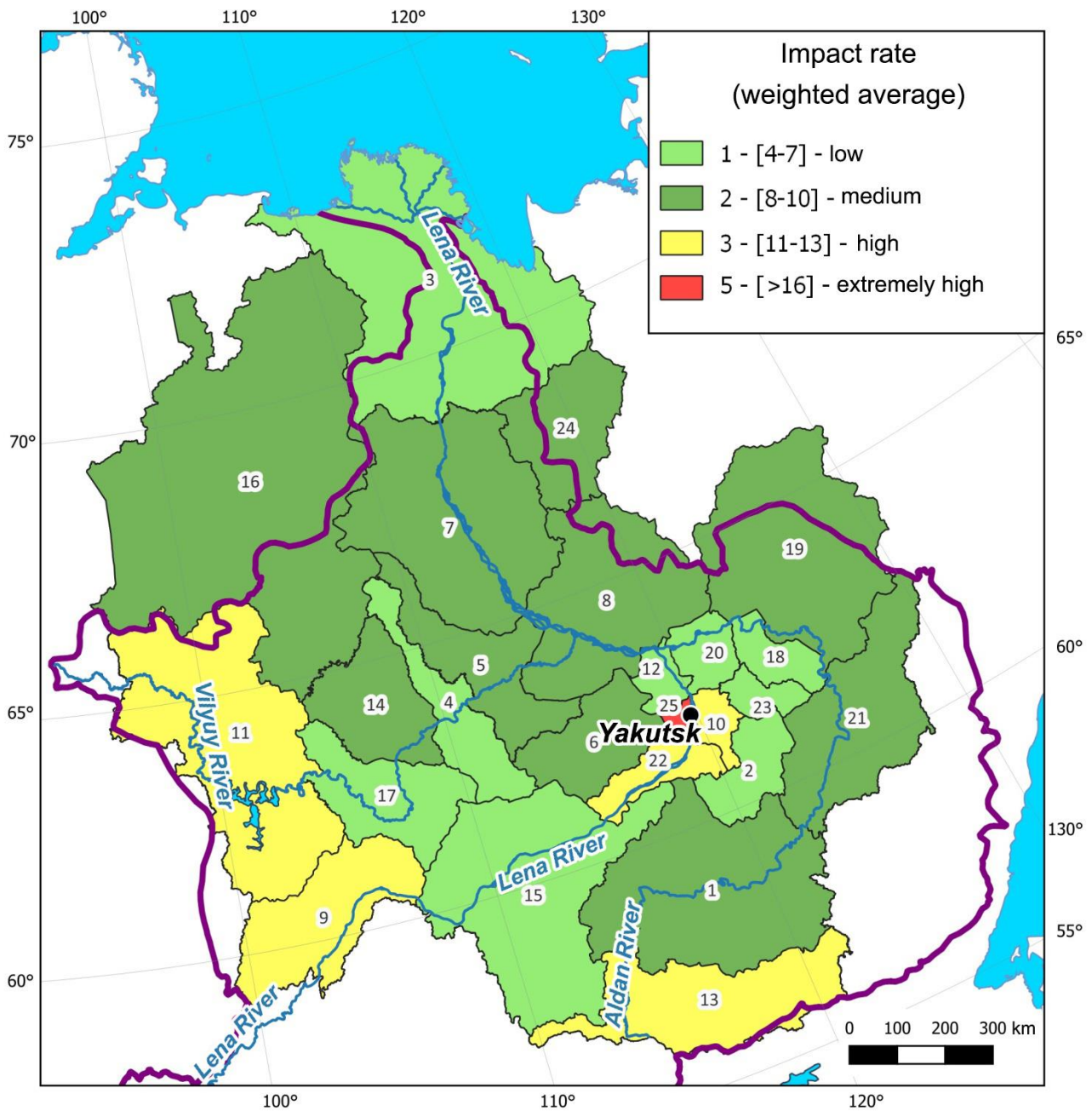


Fig. 6. Overview map of the degree of negative industrial impact on the environment in the Lena basin: social and ecological aspects.

VII. Socio-Economic and Ecological Factors (12) (Appendix Table 7a-b):

1) Number of motor vehicles registered with the State Traffic Safety Inspectorate of the Ministry of Internal Affairs of the Russian Federation in the Republic of Sakha (per 1000 ind.; *Column 3*);

2) Length of the regional public motor roads as of the end of the year (1 km/1000 km²; *Column 4*);

- 3) Number of settlements without gas infrastructure (%; *Column 5*);
- 4) Number of settlements without water supply infrastructure (%; *Column 6*);
- 5) Number of settlements without waste-water disposal system (%; *Column 7*);
- 6) Total area of accommodation (m²/ind.; *Column 8*);
- 7) Single line of outside water supply infrastructure (m; *Column 9*);
- 8-12) Distribution of companies by their activity type (unit per 10000 ind.): 8 – agriculture, forestry, hunting, fishing and fishery (*Column 10*), 9 – mining (*Column 11*), 10 – manufacturing (*Column 12*), 11 – construction (*Column 13*), 12 – transportation and storage (*Column 14*).

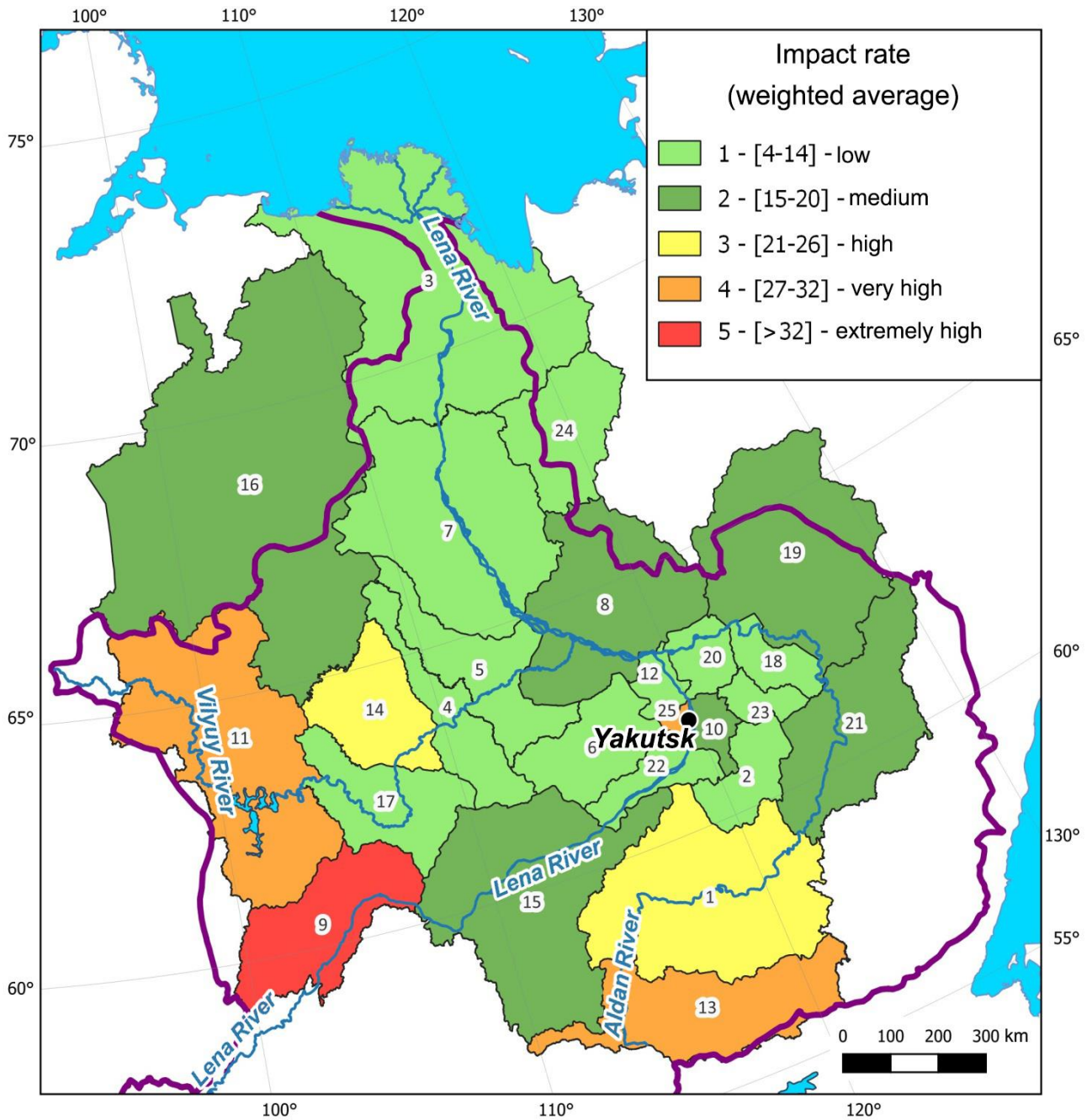


Fig. 7. Overview map of the degree of negative industrial impact on the environment in the Lena basin: ecological and economic aspects.

Total industrial load of this group: 1 – 12-21 (low), 2 – 22-31 (medium), 3 – 32-39 (high), 4 – 40-48 (very high), 5 – higher than 48 (extremely high).

Socio-economic and ecological factors had the highest negative impact on the Lena Basin. Their minimal impact (medium) was recorded in Bulunsky, Verkhnevilyuysky, Namsky, Churapchinsky and Eveno-Bytantaysky districts (Fig. 8), while the rest of the districts were under the high impact, with Yakutsk, Aldansky and Lensky districts being under the extremely high impact.

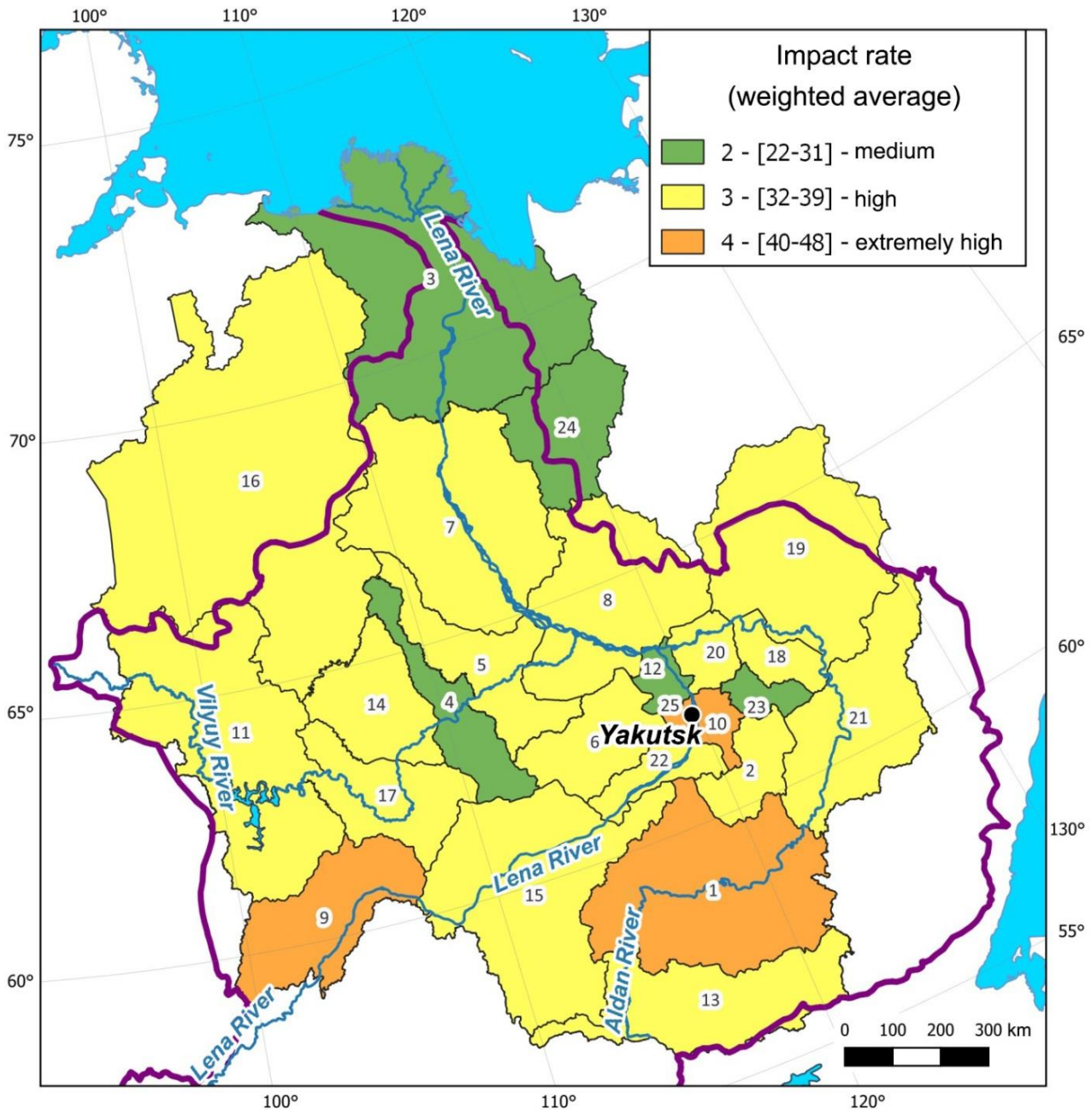


Fig. 8. Overview map of the degree of negative industrial impact on the environment in the Lena basin: social and economic, and environmental aspects.

VIII. Radioactive Fallout from the Atmosphere (1) (Appendix Table 8):

1) Daily maximum gamma radiation dose level (microR/hr; Column 3).

Radiation in most districts did not exceed the average 15 microR/hr for Sakha. It was medium in 5 districts (Aldansky, Zhigansky, Lensky, Neryungrinsky, Ust-Maysky), and high in Tattinsky District (Fig. 9).

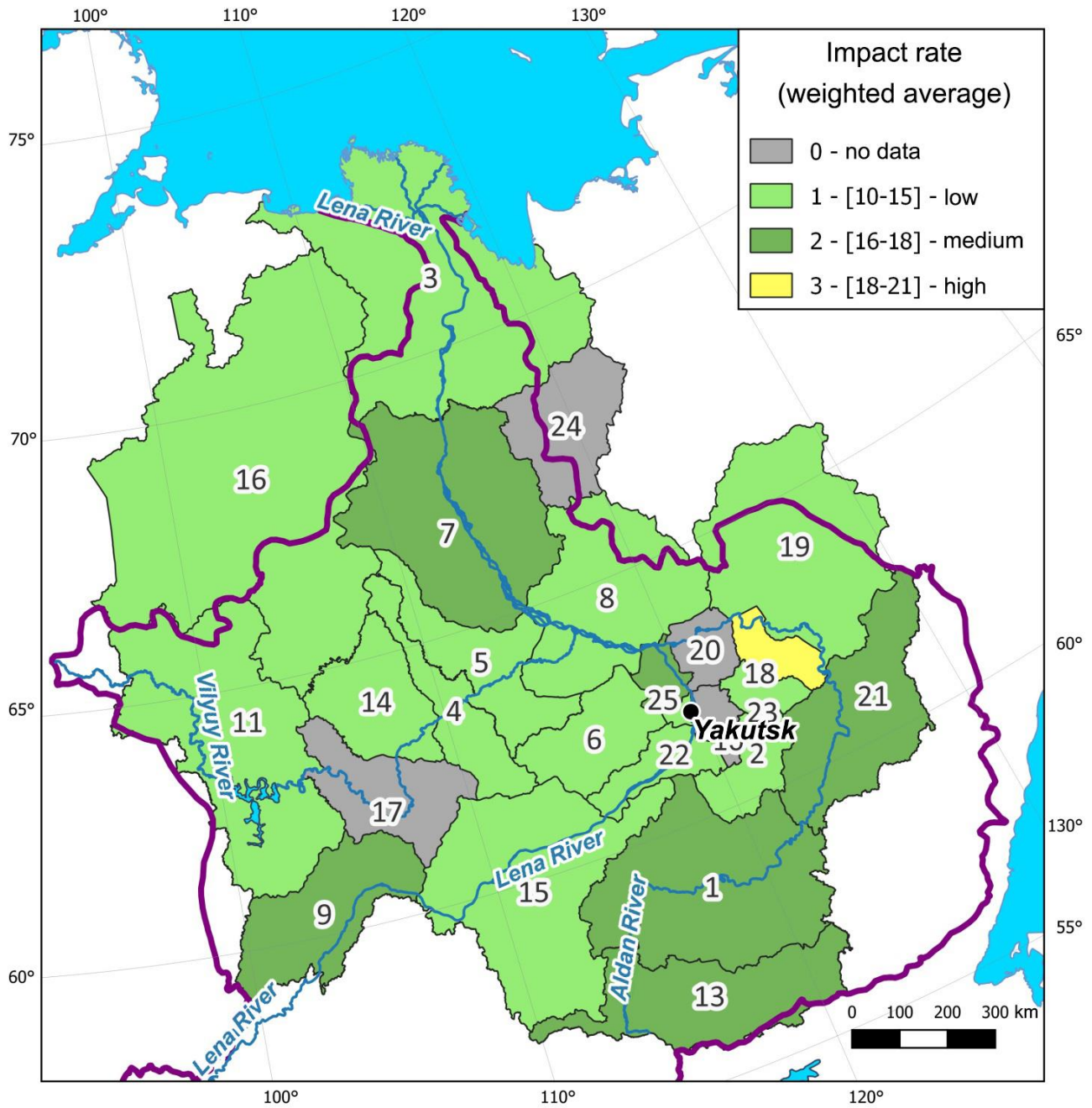


Fig. 9. Overview map of the degree of negative industrial impact on the environment in the Lena basin: radioactive fallout.

Industrial load indicators with positive environmental impact were accessed by groups: I – ecological factors: specially protected natural areas (protected plants and mushrooms, protected animals), II – forest resources, III – land use structure and ecological-economic factors.

I. Ecological Factors: Specially Protected Natural Areas (3) (Appendix Table 9):

1) Specially protected natural areas (% of the district; *Column 3*);

2) Protected plant and mushroom species (% of the Red Data Book species of the Lena River basin; *Column 4*);

3) Protected animal species (% of the Red Data Book species of the Lena River Basin; *Column 5*).

Total positive impact of this group (*Column 6*): 1 – 3-5 (low), 2 – 6-7 (medium), 3 – 8-9 (high), 4 – 10-11 (very high), 5 – higher than 11 (extremely high).

A significant *positive* impact on the environment was registered in 7 districts: Lensky, Neryungrinsky, Olenyoksky and Tomponsky with high impact, and Aldansky and Olyokminsky with very high impact (Fig. 10). Other districts were under either low or medium impact.

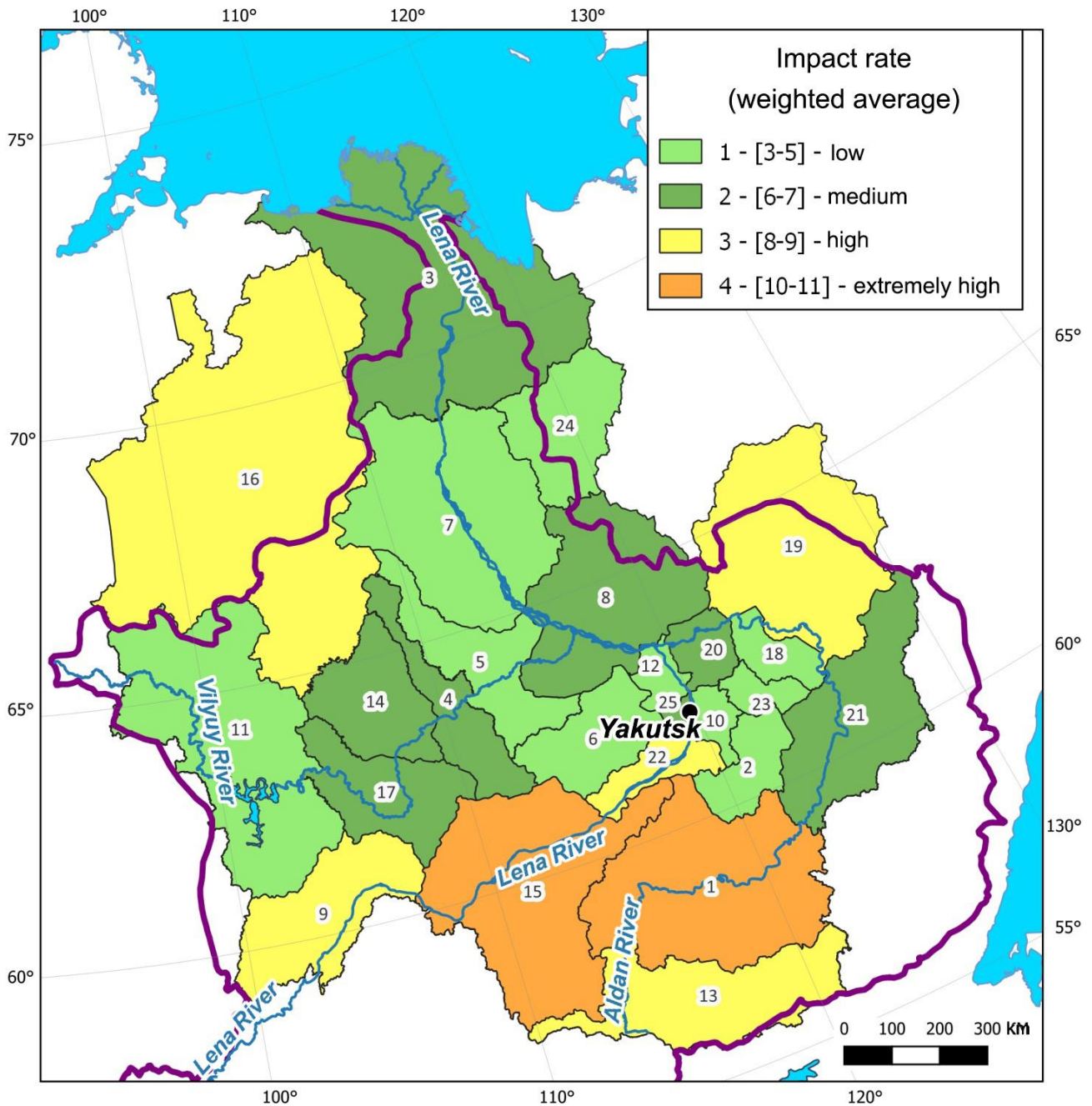


Fig. 10. Overview map of the degree of negative industrial impact on the environment in the Lena basin: ecological aspects (specially protected natural areas).

II. Forest Resources (I) (Appendix Table 10):

1) Forest cover (%): 1 – less than 20 (low), 2 – 20-40 (medium), 3 – 40-60 (high), 4 – 60-80 (very high), 5 – higher than 80 (extremely high).

The districts with the most forest cover are located in the south and west of Sakha (Fig. 11), while the districts with the less cover are found in the basin of the Lower Lena River.

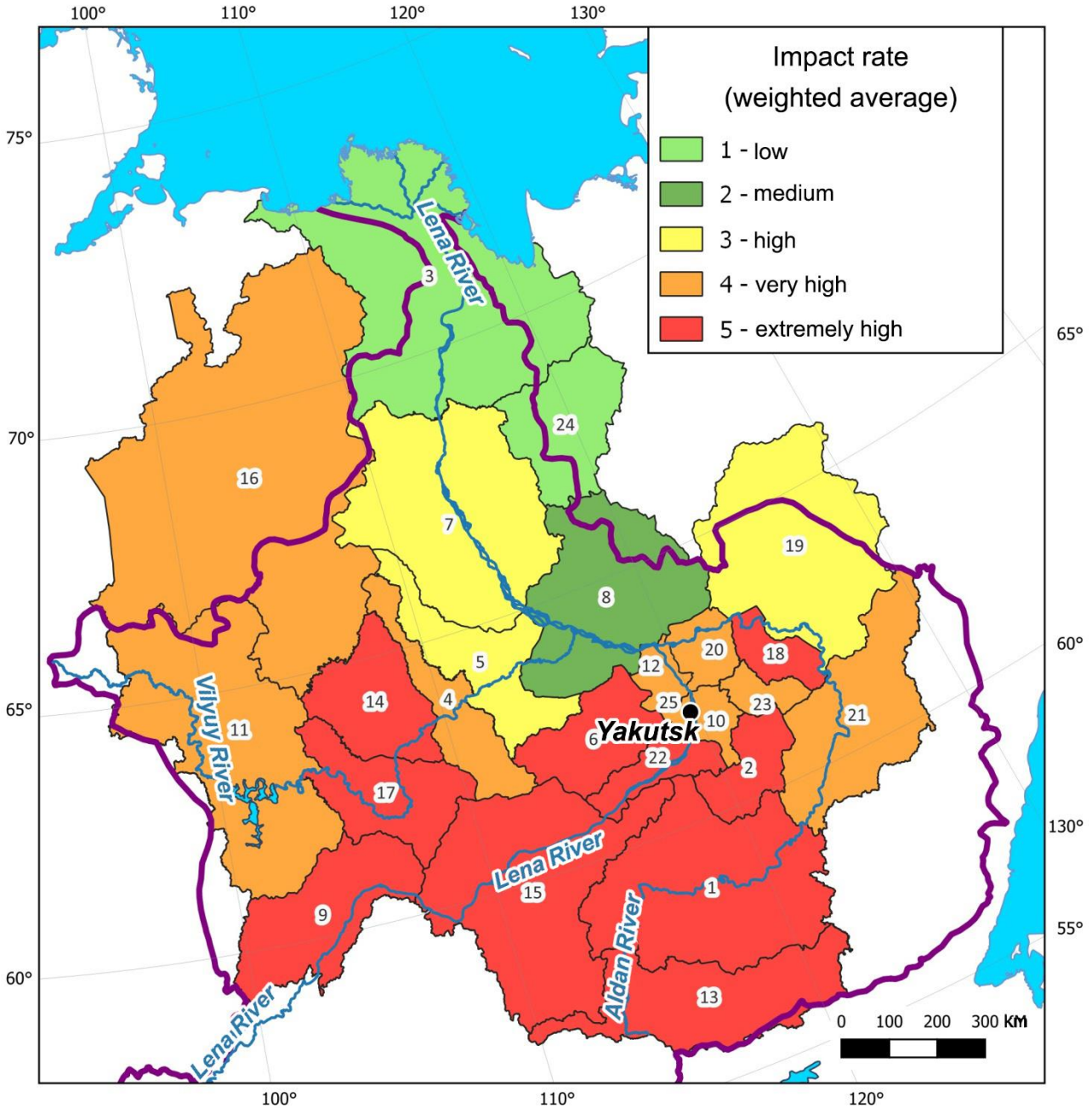


Fig. 11. Overview map of the degree of negative industrial impact on the environment in the Lena basin: forest resources.

III. Land Use Structure and Ecological-Economic Factors (4) (Appendix Table 11):

- 1) Distribution of agricultural lands as of January 1, 2021: fallows (%; *Column 3*);
- 2-4) Distribution of companies by their activity type (unit per 10000 ind.): 2 – water supply,

water discharge, waste catchment and disposal, pollution elimination (*Column 4*), 3 – education (*Column 5*), 4 – health and social services (*Column 6*).

Total positive impact of this group (Column 7): 1 – 4-7 (low), 2 – 8-10 (medium), 3 – 11-13 (high), 4 – 14-16 (very high), 5 – higher than 16 (extremely high).

Low *positive* impact of the industrial load was registered in Mirninsky District (Fig. 12).

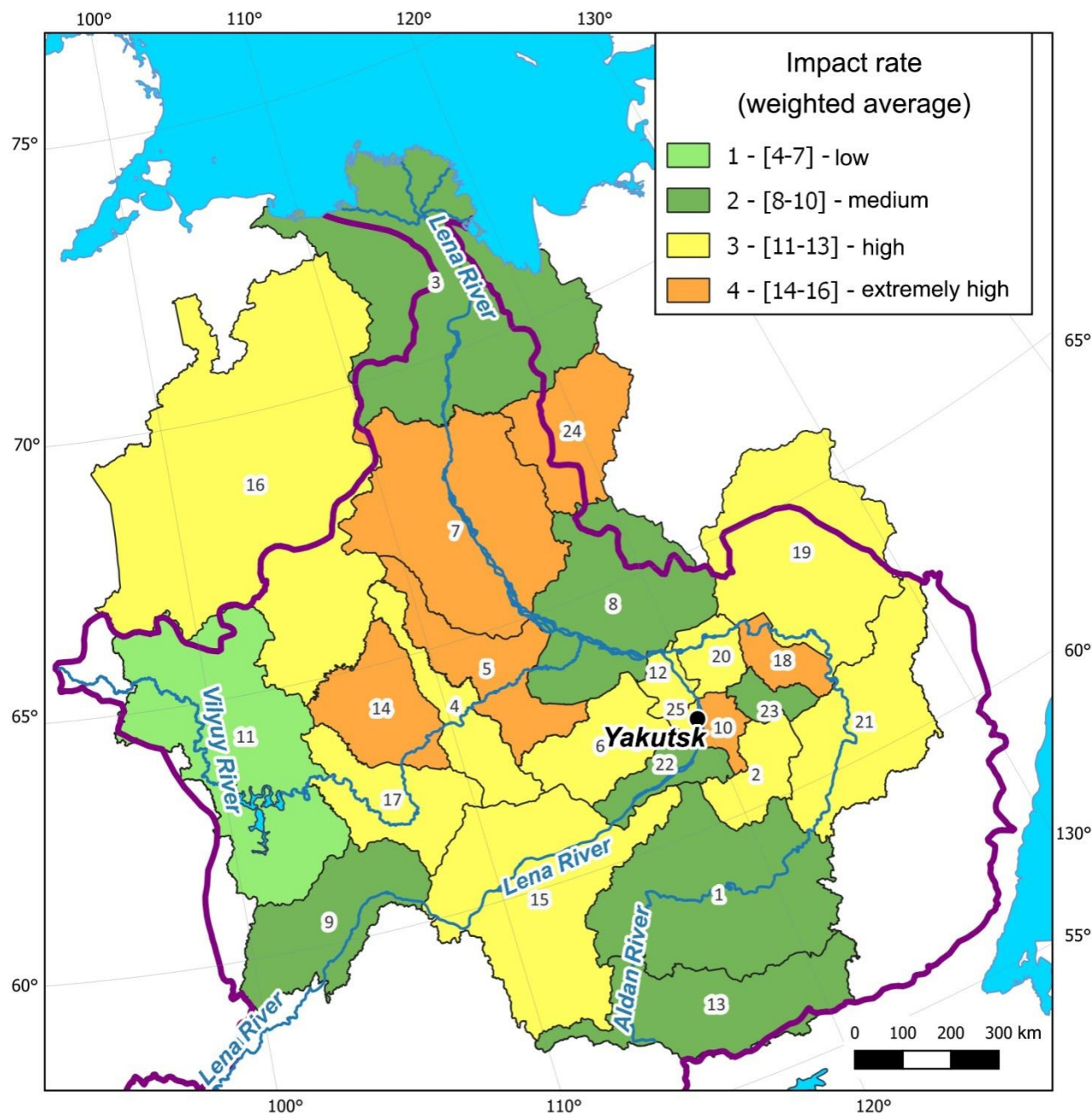


Fig. 12. Overview map of the degree of negative industrial impact on the environment in the Lena basin: land use structure, and ecological and economic aspects.

In 6 more districts (Vilyuysky, Zhigansky, Megino-Kangalassky, Nyurbinsky, Tattinsky и Eveno-Bytantaysky) it was very high, but medium and high in the rest of them.

Negative integral industrial load was evaluated by combining the total data for all 8 groups and

the following compilation of a map. Low integral load on the environment was registered in 12 districts, such as Bulunsky, Verkhnevilyuysky, Gorny, Zhigansky, Namsky, Olenyoksky, Suntarsky, Tattinsky, Tomponsky, Ust-Aldansky, Churapchinsky and Eveno-Bytantaysky. It was medium in 6 more districts (Amginsky, Vilyuysky, Kobyaysky, Olyokminsky, Ust-Maysky, Khangalassky), high in 3 districts (Aldansky, Megino-Kangalassky, Nyurbinsky), very high in 3 districts (Lensky, Mirninsky, Neryungrinsky), and extremely high in Yakutsk Urban District.

Integral industrial load with *negative* impact on the environment (Appendix Table 12, *Column 11*): 1 – 7-12 (low), 2 – 13-17 (medium), 3 – 18-22 (high), 4 – 23-28 (very high), 5 – higher than 28 (extremely high).

Low integral load was registered in 9 districts: Bulunsky, Verkhnevilyuysky, Gorny, Zhigansky, Namsky, Suntarsky, Ust-Aldansky, Churapchinsky and Eveno-Bytantaysky (Fig. 13). It was medium in 8 districts (Amginsky, Vilyuysky, Kobyaysky, Olyokminsky, Olenyoksky, Tattinsky, Tomponsky, Khangalassky), high in 3 (Megino-Kangalassky, Nyurbinsky, Ust-Maysky), very high in other 3 (Aldansky, Lensky, Mirninsky), and extremely high in Neryungrinsky District and Yakutsk Urban District.

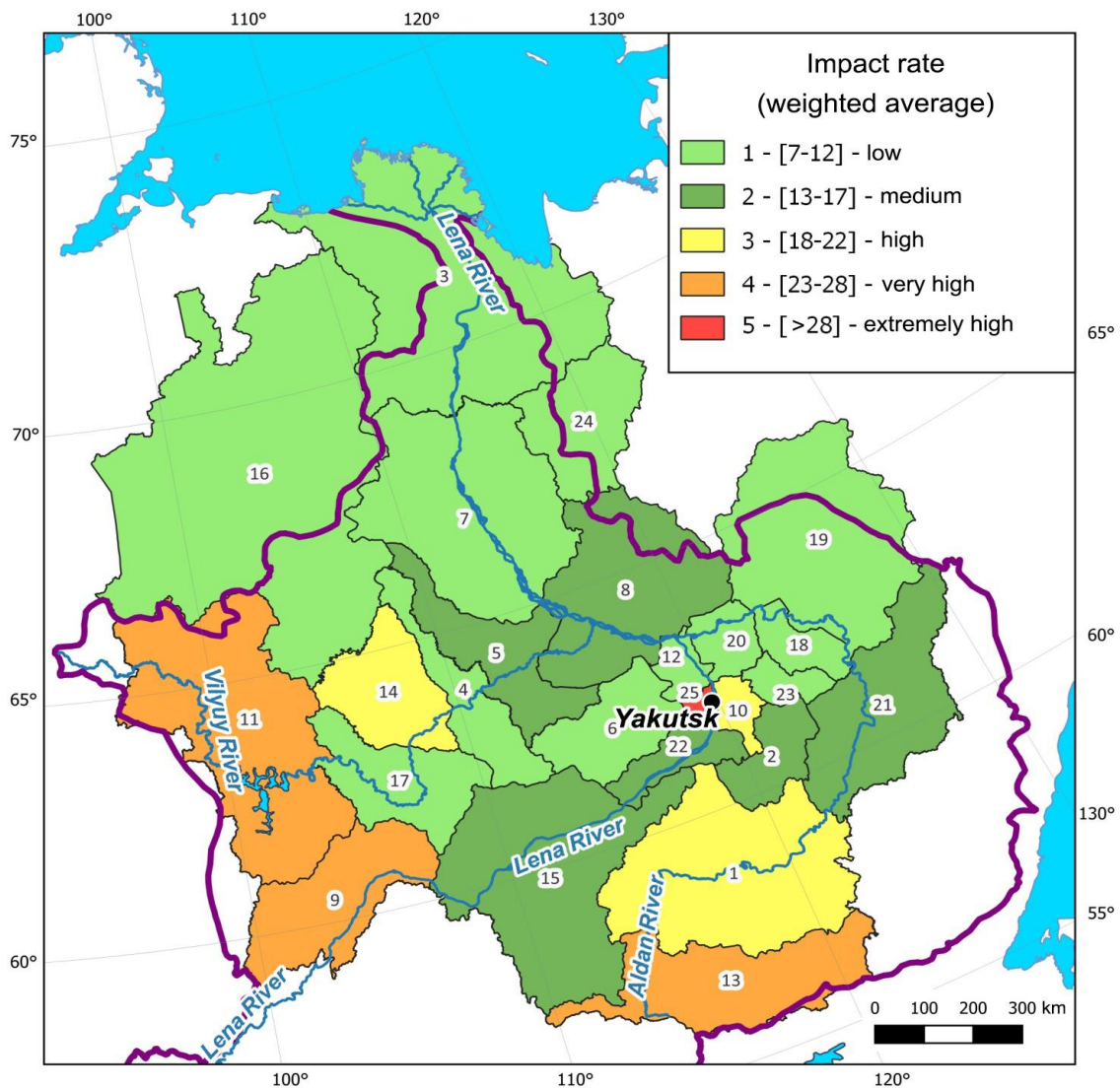


Fig. 13. Overview map of the degree of integral negative industrial impact on the environment in the Lena basin.

Positive integral impact (Appendix Table 13, Column 6): 1 – 3-5 (low), 2 – 6-7 (medium), 3 – 8-9 (high), 4 – 10-11 (very high), 5 – higher than 11 (extremely high).

Low *positive* impact of integral industrial and natural load on the environment was registered only in Bulunsky District (Fig. 14). It was medium in 4 districts (Kobyaysky, Mirninsky, Churapchinsky, Eveno-Bytantaysky), high in 11 (Amginsky, Verkhnevilyuysky, Vilyuysky, Gorny, Zhigansky, Megino-Kangalassky, Namsky, Tomponsky, Ust-Aldansky, Ust-Maysky and Uakutsk Urban District), very high in 8 (Aldansky, Lensky, Neryungrinsky, Nyurbinsky, Olenyoksky, Suntarsky, Tattinsky, Khangalassky), and extremely high in Olyokminsky District.

Positive integral impact was evaluated for 3 groups with a following compilation of a map.

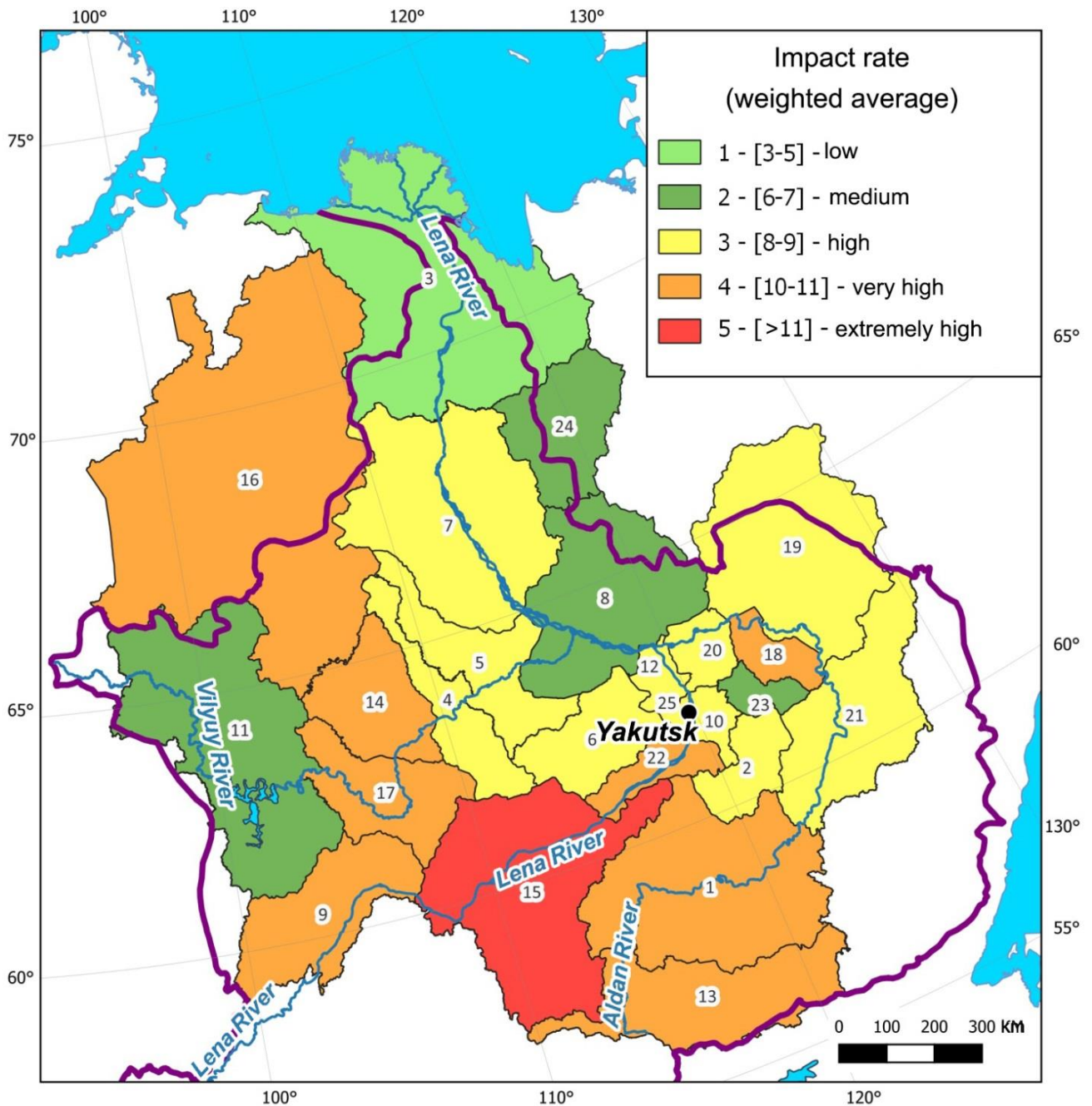


Fig. 14. Overview map of the positive integral industrial impact on the Lena basin environment.

Results and Discussion

A very high industrial load in Aldansky and Lensky districts caused a very high *positive* impact on their environment; in Mirninsky District the impact was medium (Appendix Table 14).

A high industrial load in Nyurbinsky District caused a very high *positive* impact, and high impact in Megino-Kangalassky District.

Yakutsk and Neryungrinsky District were under an extremely high load with a high (very high) *positive* impact on their environment.

The most favorable condition of the environment was registered only in Suntarsky District with low industrial load and very high *positive* impact. The load in Verkhnevilyuysky, Gorny, Zhigansky, Namsky and Ust-Aldansky districts was low, with high *positive* impact.

Bulunsky District was under a low industrial load with similarly low *positive* impact on the environment, which is considered acceptable in this particular case.

The load measures from low to medium in other districts of Sakha, while the *positive* impact on the environment varies from medium to extremely high (Appendix Table 14).

Conclusions

It should be noted that all districts with high and extremely high integral industrial load experience high or extremely high environmental impact. This may indicate that environmental protection in these districts is more seriously developed only around those environmental aspects that were used in our study and that do not fully depict the diversity of natural and industrial factors affecting the ecological state of the environment within the study area.

As additional data on the state of the environment in the area become available, the integral assessment can be repeatedly supplemented and expanded.

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APPENDIX

Appendix Table 1. Air condition.

No.	District	Pollutant emissions from the stationary sources, thousand tons		Volume of atmospheric emissions, % of the total emissions in Sakha		Polluting enterprises, units		Stationary sources of pollution, units		TOTAL	
		3	4	4	3	5	4	6	5	7	4
1	Aldansky	17.385	4	6.07	3	47	4	1396	5	16	4
2	Amginsky	4.52	2	1.58	2	11	2	231	3	9	2
3	Bulunsky	0.84	1	0.29	1	7	1	99	1	4	1
4	Verkhnevilyuysky	0.62	1	0.22	1	10	1	152	2	5	1
5	Vilyuysky	1.08	2	0.38	1	14	2	525	4	9	2
6	Gorny	1.89	2	0.66	1	9	1	141	2	6	1
7	Zhigansky	1.73	2	0.6	1	7	1	76	1	5	1
8	Kobyaysky	3.01	2	1.1	2	13	2	215	3	9	2
9	Lensky	48.35	5	16.9	4	49	4	2382	5	18	5
10	Megino-Kangalassky	1.26	2	0.44	1	16	2	299	3	8	2
11	Mirninsky	80.9	5	28.3	5	42	4	2521	5	19	5
12	Namsky	0.844	1	0.29	1	5	1	84	1	4	1
13	Neryungrinsky	36.2	5	12.6	4	36	4	696	4	17	5
14	Nyurbinsky	6.45	3	2.25	2	28	3	535	4	12	3
15	Olyokminsky	9.67	3	3.38	2	25	3	713	4	12	3
16	Olenyoksky	0.92	1	0.32	1	7	1	61	1	4	1
17	Suntarsky	2.35	2	0.82	1	18	2	304	3	8	2
18	Tattinsky	4.36	2	1.52	2	13	2	207	3	9	2
19	Tomponsky	5.78	3	2.74	2	14	2	293	3	10	2
20	Ust-Aldansky	3.75	2	1.31	2	11	2	298	3	9	2
21	Ust-Maysky	3.51	2	1.23	2	14	2	305	3	9	2
22	Khangalassky	3.06	2	1.06	2	21	3	315	3	10	2
23	Churapchinsky	3.55	2	1.24	2	9	1	185	2	7	1
24	Eveno-Bytantaysky	0.136	1	0.048	1	4	1	26	1	4	1
25	Yakutsk	9.73	3	3.4	2	72	5	1396	5	15	4

Notes to tables 1-13. Industrial impact: 0 – no pollution or no data, 1 – low, 2 – medium, 3 – high, 4 – very high, 5 – extremely high.

Appendix Table 2. Condition of water resources.

No.	District	Water sampling from the natural sources, million m ³		Wastewater discharge, million m ³		Water usage, million m ³				Structure of fresh water usage, million m ³					TOTAL		
						Water intake from the natural sources for further usage		Water discharge into the surface water bodies		Manufacturing needs		Производственные		Agricultural supply and irrigation			
1	2	3		4		5		6		7		8		9		10	
1	Aldansky	13.58541	4	9.13646	3	12.4	4	6.7	3	2.255	4	7.231	3	n/a	0	21	3
2	Amginsky	0.23878	1	0.012	1	n/a	0	n/a	0	0.094	1	0.117	1	0.003	1	5	1
3	Bulunsky	1.32738	2	1.39534	2	1.33	2	0.78	1	0.117	2	0.783	1	n/a	0	10	1
4	Verkhnevilyuysky	2.64561	2	2.6823	2	0.65	1	2.68	2	0	0	0.019	1	2.229	4	12	1
5	Vilyuysky	0.47979	1	0.15136	1	0.48	1	0.148	1	0.08	1	0.16	1	0.15	3	9	1
6	Gorny	0.0597	1	0.00331	1	0.061	1	0	0	0.033	1	0.006	1	n/a	0	5	1
7	Zhigansky	0.40987	1	0.2761	1	0.41	1	0.28	1	0.068	1	0.342	1	n/a	0	6	1
8	Kobyaysky	0.79354	1	0.23103	1	0.79	1	0.007	1	0.224	2	0.533	1	n/a	0	7	1
9	Lensky	17.09248	4	3.14756	2	17.09	4	3	2	1.66	4	2.68	2	n/a	0	18	3
10	Megino-Kangalassky	24.91701	5	22.65422	5	24.92	5	22.51	5	0.4	2	0.15	1	28.93	5	28	4
11	Mirninsky	46.1293	5	44.04597	5	46.1	5	28.3	5	4.9	4	28.13	5	0	1	30	5
12	Namsky	0.20667	1	0.00014	1	0.21	1	n/a	0	0.106	2	0.039	1	0.061	2	8	1
13	Neryungrinsky	38.91895	5	28.11045	5	38.92	5	25.45	5	4.79	4	13.81	4	0.034	2	30	5
14	Nyurbinsky	3.90119	2	3.02658	2	3.9	2	2.91	2	0.24	2	0.52	1	2.63	4	15	2
15	Olyokminsky	1.56692	2	0.16067	1	1.57	2	0.16	1	0.44	2	1.1	2	n/a	0	10	1
16	Olenyoksky	0.47921	1	0.65851	1	0.479	1	0.034	1	0.039	1	0.44	1	n/a	0	6	1
17	Suntarsky	0.70831	1	0.18474	1	0.71	1	0.18	1	0.013	1	0.198	1	0.453	3	9	1
18	Tattinsky	0.1574	1	n/a	0	0.16	1	n/a	0	0.061	1	0.076	1	0.015	2	6	1
19	Tomponsky	2.29086	2	1.2849	2	2.29	2	1.28	2	0.749	3	0.669	1	n/a	0	12	1
20	Ust-Aldansky	1.00626	2	0.65829	1	1.01	2	0.27	1	0.237	2	0.318	1	0	1	10	1
21	Ust-Maysky	2.95455	2	28.26805	5	2.95	2	25.7	5	0.33	2	2.016	2	n/a	0	18	3
22	Khangalassky	2.06311	2	1.84203	2	1.57	2	1.44	2	0.23	2	1.11	2	0.007	1	13	2
23	Churapchinsky	0.11875	1	n/a	0	0.12	1	n/a	0	0.00633	1	0.0568	1	0.0032	1	5	1
24	Eveno-Bytantaysky	0.01726	1	n/a	0	0.017	1	n/a	0	n/a	0	0.01726	1	n/a	0	3	1
25	Yakutsk	27.79638	5	22.64133	5	27.796	5	22.622	5	15.19	5	10.1	4	0.37	3	32	5

Appendix Table 3. Land use structure.

No.	District	Distribution of agricultural lands as of January 1, 2021, %								Cultivated area, % of the total arable area						Crop yield, tons per 1 ha of arable land						TOTAL	
		Arable lands		Hay fields		Pastures		Total of the entire district, %		Grain		Potato		Hardy vegetables		Grain		Potato		Hardy vegetables			
1	2	3		4		5		6		7		8		9		10		11		12		13	
1	Aldansky	17.49	5	51.42	5	31.10	2	0.08	1	n/a	0	9.70	2	1.62	2	0.000	1	2.21	4	0.39	2	23	2
2	Amginsky	17.77	5	44.40	4	37.81	2	3.59	3	18.32	5	0.81	1	0.11	1	0.165	5	0.09	1	0.03	1	28	3
3	Bulunsky	0.00	1	53.27	5	46.73	3	0.00	1	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	10	1
4	Verkhnevilyuysky	2.21	1	37.26	3	56.65	3	1.65	2	n/a	0	9.13	2	1.74	2	n/a	0	1.30	3	0.22	2	18	2
5	Vilyuysky	2.24	1	47.88	4	49.42	3	0.85	1	8.04	3	14.79	3	2.78	2	0.087	3	1.44	3	0.34	2	25	2
6	Gorny	1.88	1	58.94	5	38.87	2	1.20	2	n/a	0	2.80	2	1.46	2	n/a	0	0.27	1	0.46	2	17	1
7	Zhigansky	0.00	1	49.80	4	50.20	3	0.02	1	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	9	1
8	Kobyaysky	0.60	1	66.06	5	33.31	2	0.55	1	n/a	0	61.34	5	13.55	4	n/a	0	4.61	4	2.38	4	26	3
9	Lensky	17.88	5	50.85	5	26.34	2	0.21	1	n/a	0	19.81	3	2.99	2	n/a	0	2.89	4	0.87	3	25	2
10	Megino-Kangalassky	7.85	2	42.58	4	44.30	3	10.47	5	11.88	3	5.36	2	1.31	2	0.070	3	0.59	2	0.28	2	28	3
11	Mirninsky	8.83	3	55.82	5	31.54	2	0.06	1	n/a	0	9.43	2	1.49	2	n/a	0	2.92	4	0.34	2	21	2
12	Namsky	6.16	2	29.51	2	64.20	4	9.17	4	n/a	0	6.97	2	1.60	2	n/a	0	0.64	2	0.19	2	20	2
13	Neryungrinsky	2.83	1	0.00	1	97.17	5	0.02	1	n/a	0	76.77	5	39.08	5	n/a	0	11.42	5	8.15	5	28	3
14	Nyurbinsky	3.01	1	51.79	5	41.37	3	1.61	2	5.48	2	10.18	3	1.54	2	0.089	3	0.74	2	0.18	2	25	2
15	Olyokminsky	14.96	4	29.09	2	52.97	3	0.44	1	5.10	2	6.63	2	0.36	1	0.091	3	0.78	2	0.06	1	21	2
16	Olenyoksky	0.00	1	55.10	5	44.90	3	0.04	1	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	10	1
17	Suntarsky	6.84	2	49.91	4	43.02	3	2.07	3	8.19	3	1.45	2	0.28	1	0.090	3	0.09	1	0.03	1	23	2
18	Tattinsky	4.49	2	47.58	4	44.32	3	4.52	3	n/a	0	3.36	2	0.67	1	0.000	1	0.49	1	0.16	2	18	2
19	Tomponsky	6.26	2	24.17	2	69.57	4	0.27	1	n/a	0	3.30	2	0.94	1	0.000	1	0.17	1	0.10	2	15	1
20	Ust-Aldansky	5.45	2	40.08	4	54.46	3	7.89	4	13.79	4	2.36	2	0.46	1	0.172	5	0.15	1	0.08	1	27	3
21	Ust-Maysky	1.53	1	69.20	5	28.39	2	0.29	1	n/a	0	30.56	4	5.62	3	n/a	0	3.92	4	0.82	3	23	2
22	Khangalassky	8.39	3	40.62	4	50.79	3	4.25	3	17.55	5	6.89	2	0.93	1	0.178	5	0.92	2	0.17	2	30	3
23	Churapchinsky	6.34	2	42.17	4	51.50	3	10.58	5	1.41	1	n/a	2	n/a	1	n/a	0	0.10	1	0.03	1	20	2
24	Eveno-Bytantaysky	0.00	1	49.85	4	50.15	3	0.21	1	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	9	1
25	Yakutsk	15.08	4	37.21	3	47.22	3	12.39	5	5.35	2	17.60	3	5.70	3	0.066	3	1.68	3	1.13	4	33	4

Appendix Table 4. Structure of livestock.

No.	District	Density of livestock, number of heads per 100 ha of pastures										Number of birds, thousand heads		Number of sheep, goats and rabbits, heads		TOTAL	
		Cattle		Cows		Pigs		Horses		Rein- deer							
1	2	3		4		5		6		7		8		9		10	
1	Aldansky	19	2	10	3	44.3	5	18	2	204	4	1.8	2	48	2	20	3
2	Amginsky	30	3	12	4	1.7	2	32	4		0	4.0	2		0	15	2
3	Bulunsky	4	1	3	1	6.8	3	67	5	3092	5		0		0	15	2
4	Verkhnevilyuysky	27	3	10	3	0.8	1	21	3		0	1.2	2	286	4	16	2
5	Vilyuysky	48	5	19	5	2.0	2	36	4		0	0.6	1	55	3	20	3
6	Gorny	22	3	10	3	0.1	1	22	3		0	1.1	2	989	5	17	2
7	Zhigansky	6	1	2	1	0.7	1	1	1	240	4	0.1	1		0	9	1
8	Kobyaysky	24	3	10	3	1.1	2	17	2	34	2	1.7	2	79	3	17	2
9	Lensky	38	4	18	5	14.2	4	37	4		0	4.6	2	22	1	20	3
10	Megino-Kangalassky	37	4	13	4	0.5	1	30	4		0	3.9	2	71	3	18	3
11	Mirninsky	31	4	14	4	1.6	2	16	2		0	73.7	5		0	17	2
12	Namsky	15	2	6	2	0.6	1	18	2		0	2.2	2	441	4	13	2
13	Neryungrinsky	12	2	5	2	70.2	5	3	1	291	4	246.2	5	310	4	23	4
14	Nyurbinsky	36	4	13	4	0.4	1	31	4		0	42.4	4	69	3	20	3
15	Olyokminsky	16	2	7	2	0.8	1	18	2	14	2	7.9	3	456	4	16	2
16	Olenyoksky	18	2	8	2	4.0	2	30	3	906	5	0.1	1	13	1	16	2
17	Suntarsky	27	3	11	3	0.3	1	25	3		0	1.9	2	211	4	16	2
18	Tattinsky	38	4	15	4	1.0	2	37	4		0	2.5	2		0	16	2
19	Tomponsky	10	1	4	1	0.4	1	8	1	26	2	2.3	2	135	4	12	1
20	Ust-Aldansky	19	2	7	2	0.1	1	18	2		0	1.9	2		1	9	1
21	Ust-Maysky	11	2	4	2	0.4	1	15	2	4	1	1.9	2	250	4	14	2
22	Khangalassky	17	2	7	2	0.6	1	26	3		0	3.2	2	190	4	14	2
23	Churapchinsky	29	3	11	3	0.4	1	23	3		0	2.2	2	103	4	16	2
24	Eveno-Bytantaysky	13	2	6	2	0.0	1	30	4	238	4	0.1	1		1	13	2
25	Yakutsk	16	2	7	2	62.1	5	16	2		0	449.5	5	252	4	20	3

Appendix Table 5. Socio-ecological factors.

No.	District	Population density, ind./km ²		City population, %		Natural population growth, per 1000 ind.		Net migration, per 1000 ind.		TOTAL	
		3	2	4	5	5	1	6	1	7	7
1	Aldansky	0.25	2	89.81	5	-5.4	1	-3.1	1	9	2
2	Amginsky	0.57	0	0.00	0	7.1	4	-3.3	1	5	1
3	Bulunsky	0.04	1	55.82	3	0.9	2	-2.2	1	7	1
4	Verkhnevilyuysky	0.50	0	0.00	0	9.0	4	-1.4	1	5	1
5	Vilyuysky	0.45	2	55.69	3	7.3	4	-2.3	1	10	2
6	Gorny	0.27	0	0.00	0	11.6	5	1.6	3	8	2
7	Zhigansky	0.03	0	0.00	0	2.6	3	13.4	5	8	2
8	Kobyaysky	0.11	2	29.30	2	2.1	3	-7.4	1	8	2
9	Lensky	0.47	2	87.13	5	-2.2	1	5.9	4	12	3
10	Megino-Kangalassky	2.68	3	13.97	1	7.0	4	8.8	4	12	3
11	Mirninsky	0.43	2	96.70	5	3.1	3	-7.0	1	11	3
12	Namsky	2.11	0	0.00	0	7.7	4	0.6	2	6	1
13	Neryungrinsky	0.76	2	98.52	5	-0.3	1	13.4	5	13	3
14	Nyurbinsky	0.45	2	41.11	3	6.5	4	-1.1	1	10	2
15	Olyokminsky	0.15	2	37.32	2	-1.3	1	-2.8	1	6	1
16	Olenyoksky	0.14	0	0.00	0	11.9	5	6.2	4	9	2
17	Suntarsky	0.41	0	0.00	0	6.6	4	4.2	3	7	1
18	Tattinsky	0.86	0	0.00	0	6.9	4	-1.7	1	5	1
19	Tomponsky	0.09	1	57.03	3	1.5	3	2.9	3	10	2
20	Ust-Aldansky	1.12	0	0.00	0	5.1	4	-2.5	1	5	1
21	Ust-Maysky	0.08	1	71.90	4	0.5	2	-29.9	1	8	2
22	Khangalassky	1.34	3	47.42	3	1.2	3	4.2	3	12	3
23	Churapchinsky	1.68	0	0.00	0	9.6	4	-4.5	1	5	1
24	Eveno-Bytantaysky	0.06	0	0.00	0	10.1	5	1.7	3	8	2
25	Yakutsk	96.44	5	95.23	5	6.1	4	15.8	5	19	5

Appendix Table 6. Ecological-economic factors.

No.	District	Ecological fees added to the municipal budget, thousand rubles						Current operating costs of nature protection, million rubles						9		10		TOTAL	
		3*		4		5		6		7		8						11	
1	Aldansky	24008.05	4	4238.25	3	14404.83	4	49.5	2	44.3	2	1.5	1	270371	3	72.89	4	23	3
2	Amginsky	925.08	2	311.02	2	555.05	2	0	1	0	1	n/a	0	7231	1	6.8	1	10	1
3	Bulunsky	600.03	2	39.65	1	360.02	2	0	1	0	1	0	0	121106	3	12.7	2	12	1
4	Verkhnevilyuysky	79.34	1	637.94	2	47.6	1	0	1	0	1	n/a	0	15894	2	n/a	0	8	1
5	Vilyuysky	223.3	2	65.01	1	133.98	2	21.312	2	6.952	1	n/a	0	28737	2	83.49	4	14	1
6	Gorny	57.29	1	2399.29	3	34.37	1	0	1	0	1	n/a	0	15765	2	3.5	1	10	1
7	Zhigansky	395.59	2	289	2	183.41	2	0	1	0	1	n/a	0	7365	1	n/a	0	9	1
8	Kobyaysky	278.76	2	105.03	2	167.25	2	15.968	2	0	1	0	0	140639	3	25.6	3	15	2
9	Lensky	59935.39	5	1136.27	3	35961.23	5	1017.943	5	503.593	4	176.962	3	3991697	5	105.09	5	35	5
10	Megino-Kangalassky	707.83	2	200.03	2	424.7	2	30.246	2	8.463	1	n/a	0	40424	2	168	5	16	2
11	Mirninsky	40304.01	5	1795.98	3	24182.4	4	n/a	0	1848.81	5	944.95	4	3700670	5	178.01	5	31	4
12	Namsky	52.49	1	752.52	2	48.49	1	20.478	2	2.43	1	n/a	0	24709	2	0.42	1	10	1
13	Neryungrinsky	27601.45	4	13842.01	5	16560.87	4	389.85	3	367.25	3	19.59	2	1239795	4	181.36	5	30	4
14	Nyurbinsky	23428.07	4	240.43	2	14056.84	4	121.647	3	808.338	4	0	0	980062	3	27.66	3	23	3
15	Olyokminsky	29834.26	4	742.43	2	17900.55	4	47.773	2	12.372	2	4.352	1	95483	2	25.89	3	20	2
16	Olenyoksky	5632.11	3	15.22	1	3.37926	1	62574	5	0	1	0	1	223986	3	0.6	1	15	2
17	Suntarsky	287.55	2	550.11	2	172.52	2	6.952	1	6.354	1	4.565	0	51518	2	1.33	1	12	1
18	Tattinsky	964.8	2	606.87	2	578.88	2	11.314	2	0	1	0	0	16517	2	18.5	2	13	1
19	Tomponsky	1345.2	3	334.63	2	807.12	2	18.844	2	5.251	1	0	0	35222	2	26.9	3	15	2
20	Ust-Aldansky	423.12	2	91.18	1	283.87	2	0	1	0	1	n/a	0	7943	1	5.29	1	9	1
21	Ust-Maysky	1193.38	3	0	0	716.08	2	30.13	2	n/a	5	14.83	2	66538	2	18	2	18	2
22	Khangalassky	506.05	2	365.98	2	303.63	2	60.987	2	13.777	2	n/a	0	102301	3	n/a	0	13	1
23	Churapchinsky	677.6	2	217.62	2	406.56	2	0	1	0	1	n/a	0	8419	1	9.7	1	10	1
24	Eveno-Bytantaysky	43.16	1	0	0	25.9	1	n/a	0	0	1	n/a	0	4051	1	n/a	0	4	1
25	Yakutsk	5880.4	3	8163.81	4	4154.87	3	728.65	4	401.66	3	78.43	2	1528898	4	720.4	5	28	4

Notes to Appendix Table 6: 3 – fees for negative impact on environment, 4 – fines and lawsuits fees added to the budget of the municipal divisions and municipal districts, 5 – Paid to the budget of the municipal divisions and districts after for the negative environmental impact, 6 – Costs of catchment and purification of wastewater, 7 – Costs of waste treatment, 8 – Costs of land and natural water rehabilitation and protection, 9 – Current operating costs of environment protection, including costs of nature protecting services (thousand rubles), 10 – Removal of solid household waste per year (thousand m³).

Appendix Table 7a. Social-economic and ecological factors.

No.	District	Number of motor vehicles registered with the State Traffic Safety Inspectorate of the Ministry of Internal Affairs of the Russian Federation in Sakha, per 1000 ind.		Length of the regional public roads as of the end of the year, 1 km/1000 km ²		Settlements without gas infrastructure, %		Settlements without water supply infrastructure, %		Settlements without waste-water disposal system, %		Total area of accommodation, m ² /ind.		Single line of outside water supply infrastructure, m	
		3	4	5	6	7	8	9							
1	Aldansky	361	3	2.752	2	100.00	5	36.84	2	36.84	2	29.80	4	207810	5
2	Amginsky	203	3	12.371	3	100.00	5	95.24	5	95.24	5	26.48	4	3500	2
3	Bulunsky	62	1	0.221	1	100.00	5	10.00	1	10.00	1	17.05	2	21440	3
4	Verkhnevilyuysky	182	2	26.596	3	58.62	3	68.97	4	75.86	4	20.29	3	n/a	0
5	Vilyuysky	239	3	16.074	3	40.00	2	88.00	5	88.00	5	23.00	3	29400	3
6	Gorny	289	3	14.941	3	81.25	5	62.50	4	93.75	5	23.51	3	21242	3
7	Zhigansky	123	2	0.183	1	80.00	4	60.00	3	80.00	4	22.71	3	2600	2
8	Kobyaysky	272	3	1.442	2	43.48	3	100.00	5	100.00	5	24.65	3	5500	2
9	Lensky	587	4	5.997	2	94.74	5	94.74	5	94.74	5	26.53	4	34510	3
10	Megino-Kangalassky	403	4	63.863	4	55.56	3	97.22	5	100.00	5	30.10	5	4420	2
11	Mirninsky	616	5	1.284	2	57.14	3	35.71	2	50.00	3	20.54	3	155791	4
12	Namsky	245	3	37.445	3	29.17	2	79.17	4	79.17	4	23.33	3	n/a	0
13	Neryungrinsky	395	3	2.714	2	88.89	5	0.00	0	0.00	0	22.81	3	289836	5
14	Nyurbinsky	293	3	12.309	3	100.00	5	87.50	5	100.00	5	27.57	4	210	1
15	Olyokminsky	163	2	10.348	3	94.44	5	87.04	5	94.44	5	25.68	4	6840	2
16	Olenyoksky	102	2	1.248	2	100.00	5	100.00	5	100.00	5	24.80	3	n/a	0
17	Suntarsky	272	3	11.277	3	97.44	5	94.87	5	94.87	5	26.31	4	10300	3
18	Tattinsky	295	3	19.653	3	100.00	5	93.33	5	100.00	5	26.61	4	850	1
19	Tomponsky	311	3	3.397	2	100.00	5	78.57	4	78.57	4	24.25	3	18460	3
20	Ust-Aldansky	143	2	36.842	3	100.00	5	80.00	4	85.71	5	27.16	4	43000	3
21	Ust-Maysky	232	3	3.027	2	81.25	5	56.25	3	56.25	3	26.27	4	22734	3
22	Khangalassky	289	3	23.964	3	58.62	3	55.17	3	58.62	3	23.14	3	45530	3
23	Churapchinsky	246	3	71.968	4	60.00	3	26.67	2	40.00	2	25.33	4	1380	2
24	Eveno-Bytantaysky	126	2	1.788	2	75.00	4	100.00	5	75.00	4	18.51	2	n/a	0
25	Yakutsk	348	3	135.639	5	0.00	1	66.67	4	75.00	4	21.47	3	202050	5

Appendix Table 7b. Social-economic and ecological factors.

No.	District	Distribution of companies by their activity type, unit per 10000 ind.										TOTAL	
		Agriculture, forestry, hunting, fishing and fishery		Mining		Manufacturing		Construction		Transportation and storage			
1	2	10		11		12		13		14		15	
1	Aldansky	21	2	15	5	8	4	18	3	11	3	40	4
2	Amginsky	23	2	0	0	2	3	9	2	2	1	35	3
3	Bulunsky	36	3	4	3	1	1	8	2	11	3	26	2
4	Verkhnevilyuysky	22	2	1	1	4	3	11	3	2	1	29	2
5	Vilyuysky	16	2	1	2	6	4	11	3	3	1	36	3
6	Gorny	23	2	0	0	7	4	5	1	3	1	34	3
7	Zhigansky	110	5	0	0	2	3	19	3	7	2	32	3
8	Kobyaysky	36	3	2	3	7	4	7	2	2	1	36	3
9	Lensky	7	1	1	2	5	4	15	3	14	3	41	4
10	Megino-Kangalassky	13	2	1	1	7	4	14	3	5	2	40	4
11	Mirninsky	4	1	3	3	5	4	16	3	52	5	38	3
12	Namsky	21	2	0	0	8	4	18	3	4	1	29	2
13	Neryungrinsky	7	1	14	5	9	4	23	3	28	4	35	3
14	Nyurbinsky	15	2	2	2	8	4	11	3	4	1	38	3
15	Olyokminsky	11	2	2	3	3	3	5	2	4	1	37	3
16	Olenyoksky	88	4	5	3	5	3	21	3	7	2	37	3
17	Suntarsky	22	2	0	0	8	4	5	2	2	1	37	3
18	Tattinsky	16	2	2	2	6	4	8	2	2	1	37	3
19	Tomponsky	22	2	2	3	13	5	6	2	5	1	37	3
20	Ust-Aldansky	39	3	0	0	4	3	2	1	1	1	34	3
21	Ust-Maysky	37	3	15	5	3	3	10	2	7	2	38	3
22	Khangalassky	19	2	2	2	11	5	17	3	4	1	34	3
23	Churapchinsky	36	3	0	0	1	1	14	3	1	1	28	2
24	Eveno-Bytantaysky	49	3	0	0	3	3	0	0	7	2	27	2
25	Yakutsk	7	1	10	4	17	5	67	5	19	3	43	4

Appendix Table 8. Radioactive fallout.

No.	District	Daily maximum gamma radiation dose level, microR/hr	
		1	2
1	Aldansky	18	2
2	Amginsky	15	1
3	Bulunsky	14	1
4	Verkhnevilyuysky	11	1
5	Vilyuysky	15	1
6	Gorny	13	1
7	Zhigansky	16	2
8	Kobyaysky	12	1
9	Lensky	16.5	2
10	Megino-Kangalassky	n/a	0
11	Mirninsky	13	1
12	Namsky	17	2
13	Neryungrinsky	16,5	2
14	Nyurbinsky	13	1
15	Olyokminsky	14	1
16	Olenyoksky	n/a	0
17	Suntarsky	15	1
18	Tattinsky	19	3
19	Tomponsky	14.67	1
20	Ust-Aldansky	n/a	0
21	Ust-Maysky	17	2
22	Khangalassky	15	1
23	Churapchinsky	14	1
24	Eveno-Bytantaysky	n/a	0
25	Yakutsk	14	1

Appendix Table 9. Ecological factors: specially protected natural areas.

No.	District	Specially protected natural areas, % of the district		Protected plant and mushroom species, %		Protected animal species, %		TOTAL	
		1	2	3	4	5	6	7	8
1	Aldansky	45.39	3	39.74	4	36.52	4	11	4
2	Amginsky	25.31	2	5.45	1	18.26	2	5	1
3	Bulunsky	18.27	1	16.99	2	21.74	3	6	2
4	Verkhnevilyuysky	23.24	2	0.96	1	20.87	3	6	2
5	Vilyuysky	26.92	2	2.24	1	20.00	2	5	1
6	Gorny	33.68	2	3.21	1	14.78	2	5	1
7	Zhigansky	35.06	2	6.41	1	20.00	2	5	1
8	Kobyaysky	23.33	2	12.50	2	25.22	3	7	2
9	Lensky	18.38	1	22.12	3	37.39	4	8	3
10	Megino-Kangalassky	20.27	2	3.21	1	20.00	2	5	1
11	Mirninsky	15.13	1	6.73	1	29.57	3	5	1
12	Namsky	13.23	1	5.13	1	18.26	2	4	1
13	Neryungrinsky	22.98	2	26.92	3	35.65	4	9	3
14	Nyurbinsky	23.55	2	1.60	1	22.61	3	6	2
15	Olyokminsky	16.62	1	58.97	5	52.17	5	11	4
16	Olenyoksky	85.21	5	0.32	1	12.17	2	8	3
17	Suntarsky	26.56	2	5.13	1	30.43	4	7	2
18	Tattinsky	37.78	2	4.17	1	16.52	2	5	1
19	Tomponsky	31.93	2	20.83	3	20.87	3	8	3
20	Ust-Aldansky	30.85	2	3.21	1	25.22	3	6	2
21	Ust-Maysky	28.84	2	14.10	2	24.35	3	7	2
22	Khangalassky	60.15	4	14.74	2	28.70	3	9	3
23	Churapchinsky	27.82	2	2.88	1	16.52	2	5	1
24	Eveno-Bytantaysky	22.64	2	2.88	1	8.70	1	4	1
25	Yakutsk	25.50	2	10.90	2	20.00	2	6	2

Appendix Table 10. Forest resources.

No.	District	Forest cover, %	
1	2	3	
1	Aldansky	81.9	5
2	Amginsky	86.4	5
3	Bulunsky	15.5	1
4	Verkhnevilyuysky	69.2	4
5	Vilyuysky	53.2	3
6	Gorny	86.5	5
7	Zhigansky	52.1	3
8	Kobyaysky	26.4	2
9	Lensky	89.8	5
10	Megino-Kangalassky	76.9	4
11	Mirninsky	67.3	4
12	Namsky	68.3	4
13	Neryungrinsky	91.5	5
14	Nyurbinsky	84.8	5
15	Olyokminsky	86.9	5
16	Olenyoksky	65	4
17	Suntarsky	86.7	5
18	Tattinsky	82.1	5
19	Tomponsky	47	3
20	Ust-Aldansky	75	4
21	Ust-Maysky	74.7	4
22	Khangalassky	86.6	5
23	Churapchinsky	78.5	4
24	Eveno-Bytantaysky	11.5	1
25	Yakutsk	64.2	4

Appendix Table 11. Land use structure and ecological-economic factors.

No.	District	Distribution of agricultural lands as of January 1, 2021, %, fallows		Distribution of companies by their activity type, unit per 10000 ind.						TOTAL	
				Water supply, water discharge, waste catchment and disposal, pollution elimination		Education		Health and social services			
1	2	3		4		5		6		7	
1	Aldansky	0.00	1	1	2	15	3	5	3	9	2
2	Amginsky	0.02	1	1	3	24	4	5	3	11	3
3	Bulunsky	0.00	1	0	1	24	4	6	3	9	2
4	Verkhnevilyuysky	3.88	4	0	2	26	5	3	2	13	3
5	Vilyuysky	0.45	1	4	5	25	5	5	3	14	4
6	Gorny	0.31	1	2	3	25	5	5	3	12	3
7	Zhigansky	0.00	1	2	4	26	5	7	4	14	4
8	Kobyaysky	0.03	1	0	1	36	5	2	2	9	2
9	Lensky	2.15	3	1	3	12	2	4	2	10	2
10	Megino-Kangalassky	5.27	5	1	3	22	4	4	2	14	4
11	Mirninsky	0.00	1	1	3	6	1	4	2	7	1
12	Namsky	0.13	1	2	3	29	5	3	2	11	3
13	Neryungrinsky	0.00	1	1	3	8	1	6	3	8	2
14	Nyurbinsky	3.83	4	3	4	22	4	5	3	15	4
15	Olyokminsky	2.96	3	0	2	27	5	5	3	13	3
16	Olenyoksky	0.00	1	0	1	28	5	9	5	12	3
17	Suntarsky	0.22	1	2	4	26	5	3	2	12	3
18	Tattinsky	3.60	4	1	2	26	5	6	3	14	4
19	Tomponsky	0.00	1	2	3	29	5	5	3	12	3
20	Ust-Aldansky	0.00	1	0	2	35	5	4	3	11	3
21	Ust-Maysky	0.88	2	3	4	25	4	4	3	13	3
22	Khangalassky	0.19	1	2	3	18	3	5	3	10	2
23	Churapchinsky	0.00	1	0	1	28	5	3	2	9	2
24	Eveno-Bytantaysky	0.00	1	3	5	24	4	10	5	15	4
25	Yakutsk	0.14	1	2	4	9	1	9	5	11	3

Appendix Table 12. Indicators of integral industrial impact *negatively* affecting the environment.

№	Улус	Condition of atmospheric air	Condition of water resources	Structure of land use	Structure of livestock	Socio-ecological factors	Ecological-economic factors	Socio-economic and ecological factors	Radioactive fallout from the atmosphere	TOTAL	
1	2	3	4	5	6	7	8	9	10	11	
1	Aldansky	4	3	2	3	2	3	4	2	23	4
2	Amginsky	2	1	3	2	1	1	3	1	14	2
3	Bulunsky	1	1	1	2	1	1	2	1	10	1
4	Verkhnevilyuysky	1	1	2	2	1	1	2	1	11	1
5	Vilyuysky	2	1	2	3	2	1	3	1	15	2
6	Gorny	1	1	1	2	2	1	3	1	12	1
7	Zhigansky	1	1	1	1	2	1	3	2	12	1
8	Kobyaysky	2	1	3	2	2	2	3	1	16	2
9	Lensky	5	3	2	3	3	5	4	2	27	4
10	Megino-Kangalassky	2	4	3	3	3	2	4	0	21	3
11	Mirninsky	5	5	2	2	3	4	3	1	25	4
12	Namsky	1	1	2	2	1	1	2	2	12	1
13	Neryungrinsky	5	5	3	4	3	4	3	2	29	5
14	Nyurbinsky	3	2	2	3	2	3	3	1	19	3
15	Olyokminsky	3	1	2	2	1	2	3	1	15	2
16	Olenyoksky	1	1	1	2	2	2	3	0	12	1
17	Suntarsky	2	1	2	2	1	1	3	0	12	1
18	Tattinsky	2	1	2	2	1	1	3	3	15	2
19	Tomponsky	2	1	1	1	2	2	3	1	13	2
20	Ust-Aldansky	2	1	3	1	1	1	3	0	12	1
21	Ust-Maysky	2	3	2	2	2	2	3	2	18	3
22	Khangalassky	2	2	3	2	3	1	3	1	17	2
23	Churapchinsky	1	1	2	2	1	1	2	1	11	1
24	Eveno-Bytantaysky	1	1	1	2	2	1	2	0	10	1
25	Yakutsk	4	5	4	3	5	4	4	1	30	5

Appendix Table 13. Indicators of integral industrial impact *positively* affecting the environment.

No.	District	Ecological factors: specially protected natural areas	Forest resources	Land use structure and ecological-economic factors	TOTAL	
1	2	3	4	5	6	
1	Aldansky	4	5	2	11	4
2	Amginsky	1	5	3	9	3
3	Bulunsky	2	1	2	5	1
4	Verkhnevilyuysky	2	4	3	9	3
5	Vilyuysky	1	3	4	8	3
6	Gorny	1	5	3	9	3
7	Zhigansky	1	3	4	8	3
8	Kobyaysky	2	2	2	6	2
9	Lensky	3	5	2	10	4
10	Megino-Kangalassky	1	4	4	9	3
11	Mirninsky	1	4	1	6	2
12	Namsky	1	4	3	8	3
13	Neryungrinsky	3	5	2	10	4
14	Nyurbinsky	2	5	4	11	4
15	Olyokminsky	4	5	3	12	5
16	Olenyoksky	3	4	3	10	4
17	Suntarsky	2	5	3	10	4
18	Tattinsky	1	5	4	10	4
19	Tomponsky	3	3	3	9	3
20	Ust-Aldansky	2	4	3	9	3
21	Ust-Maysky	2	4	3	9	3
22	Khangalassky	3	5	2	10	4
23	Churapchinsky	1	4	2	7	2
24	Eveno-Bytantaysky	1	1	4	6	2
25	Yakutsk	2	4	3	9	3

Appendix Table 14. Indicators of the integral industrial impact on the environment.

No.	District	Negative impact	Positive impact
1	2	3	4
1	Aldansky	very high	very high
2	Amginsky	medium	high
3	Bulunsky	low	low
4	Verkhnevilyuysky	low	high
5	Vilyuysky	medium	high
6	Gorny	low	high
7	Zhigansky	low	high
8	Kobyaysky	medium	medium
9	Lensky	very high	very high
10	Megino-Kangalassky	high	high
11	Mirninsky	very high	medium
12	Namsky	low	high
13	Neryungrinsky	extremely high	very high
14	Nyurbinsky	high	very high
15	Olyokminsky	medium	extremely high
16	Olenyoksky	medium	very high
17	Suntarsky	low	very high
18	Tattinsky	medium	very high
19	Tomponsky	medium	high
20	Ust-Aldansky	low	high
21	Ust-Maysky	high	high
22	Khangalassky	medium	very high
23	Churapchinsky	low	medium
24	Eveno-Bytantaysky	low	medium
25	Yakutsk	extremely high	high

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ОЦЕНКА ИНТЕГРАЛЬНОЙ ТЕХНОГЕННОЙ НАГРУЗКИ НА ОКРУЖАЮЩУЮ СРЕДУ В БАССЕЙНЕ РЕКИ ЛЕНА

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Оценка интегральной техногенной нагрузки впервые проведена при различных условиях развития этих влияний как негативных, так и позитивных на окружающую среду. В связи с этим исследования на территории Республики Саха (Якутия), расположенной в бассейне р. Лена, проводились в два этапа: I – в условиях влияния негативной техногенной нагрузки на окружающую среду; II – в условиях позитивного влияния на окружающую среду.

Оценка влияния техногенной нагрузки на окружающую среду проводилась по ранее разработанной нами методике, позволяющей учитывать многофакторность разноразмерных показателей, характеризующих техногенную нагрузку на изучаемые регионы, к которым относится и бассейн реки Лена.

Представленный подход базируется на простом арифметическом действии, которое позволяет объединить в расчетах все разноразмерные характеристики влияния на окружающую среду и привести их к безразмерным значениям для последующего установления степени их негативного или позитивного воздействия на среду.

Для 25 улусов (районов) Республики Саха (Якутия), расположенных в бассейне реки Лена, проанализировано 53 негативных показателя состояния различных компонентов окружающей среды, объединенных в 8 групп, и 8 положительных показателей (3 группы). Для каждого показателя выделено до 5 степеней техногенной нагрузки. Для каждой группы выделено до 5 степеней интенсивности суммарной техногенной нагрузки на окружающую среду, проведена оценка суммарной техногенной нагрузки в пределах данной группы с построением соответствующей карты (11 карт).

Ключевые слова: окружающая среда, техногенная нагрузка, водные ресурсы, экологические, экономические и социальные аспекты влияния, негативное и позитивное влияние на окружающую среду.

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