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Far East region's Key Advantages Realization by the Example of the NEFU Proving Ground in the "Kangalassy" Advanced Special Economic Zone

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Abstract. The article is devoted to the implementation of the investment project of the North-Eastern Federal University Proving Ground on the territory of Advanced Special Economic Zone "Industrial Park "Kangalassy", which is distinguished by the use of natural climatic and geographical features of the region for research, production and commercial purposes. Projects in the field of use of unique climatic conditions assume creation of the scientific proving grounds, the research centers, development and advance of services of the centers of collective use. Having test and lab equipment they allow to carry out experimental completion and tests of trial samples of machines, materials and technologies in natural extreme conditions. The uniqueness and importance of the proving ground as a universal testing center for various materials, machines and equipment is indicated. The materials presented in the article are the result of extensive preliminary research, which allowed to identify competitive advantages, calculate technical and economic parameters and, as a result, implementation decision.

1. Introduction

Since 2012, seasonal tests of automobile tires have been carried out on the basis of the existing Khatyung-Yuryakh autodrome of the North-Eastern Federal University named after M.K. Ammosov (hereinafter NEFU). Taking into account modern climatic trends and the wishes of the clients of the proving ground (hereinafter PG), NEFU has started a project to create a new test center in the permafrost zone with the Arctic climate and low temperatures long period. The establishment of a PG on the territory of advanced socio-economic zone (hereinafter ASEZ) "Industrial Park "Kangalassy"[1, 2] involves the construction of a scientific and production site for technical tests and scientific research, innovation, technical and methodological activities, first of all, in the field of improving the reliability of vehicles, equipment, products and materials in the Arctic conditions.

2. Relevance, scientific significance

Northern urban agglomerations always act as reference centers of quite extensive territory, and their cores play the central role. Such agglomerations are places of concentration of production and infrastructure capacities of the region, they concentrate objects of science, education, health care, culture, financial institutions and other social organizations. These agglomerations are closely connected, albeit by a few transport highways, with other cities and rural settlements of their sphere of influence in order to meet the diverse needs of the population [3]. It is no accident, according to



academician A.I. Tatarin, "the largest cities are leaders of investment, innovative, social processes, points of economic growth, and the growth rate of the economy of the whole country depends to a large extent on their development strategy" [4].

3. Task setting

The main goal of the project is to realize the key advantages of the region and its socio-economic development through the use of the natural and human potential of the territory, unique climatic conditions through the construction and operational activities of the PG.

4. Theoretical part

In the Republic, most cities and towns are characterized by a narrow industrial specialization. In Soviet times, small urban agglomerations arose, such as Mirninsky, which formed in the diamond mining area; Neryungrinsky, established in the area of coal mining and construction of a railway; Tikinsky, serving the needs of the seaport.

Yakutsk historically folded, developed and grew, firmly relying on the territory surrounding it. During the Soviet years, the interconnectedness between the development of Yakutsk and the suburban zone increased extremely, became more complicated and took on different proportions. This was expressed in the formation of the largest in the north-east of the country Yakut urban agglomeration, consisting of 4 urban settlements and 14 rural settlements (in the future it will consist of more than 20-25 settlements, including the right-bank part of its range after the commissioning of the bridge).

According to the data of the Federal Service of State Statistics for the Republic of Sakha (Yakutia), the number of permanent population of the Republic of Sakha (Yakutia) amounted to 964330 thousand people, including 632857 people living in urban settlements, in rural areas 331473 people [5, 6]. Today, the city of Yakutsk accounts for 31,1760 people, which is why there is the highest population density - 89.05 people. Per 1 square km, with a total population density of 0.31 persons in the country. In the dynamics of the population there is a steady trend towards its growth, so between 1990 and 2016 it increased by 67%. Population formation is due to natural and migration increases.

The climate of the city of Yakutsk is sharply continental, expressed in large fluctuations in air temperature both inside the year and during the day. In winter, the territory in question is dominated by the Siberian anticyclone, which causes stable freezing weather everywhere. In summer, the area is mostly in a low pressure area. Summer – short and hot.

The city of Yakutsk is located in the zone of spread of permafrost soils. According to construction and climatic zoning, the territory of the city belongs to the IA zone and is characterized as limited favorable for the construction of buildings and structures. Permafrost usually falls shallow from the surface. The depth of the surface "active" (i.e. thawing in summer) layer varies and depends both on the nature of the terrain and on the nature of the vegetation and the composition of the soils. Average annual air temperature by ppm Yakutsk is minus 10.2° C. The coldest month of the year is January with an average monthly air temperature of minus 42.1° C. The average monthly temperature of July, the warmest month, is plus 18.9° C. The average annual air temperature from absolute minimums is minus 25.9° C. Absolute minimum of air temperature is minus 64.4° C, and absolute maximum is plus 38.3° C. Snow cover on the territory of Central Yakutia is held for 7 months. The first appearance of snow cover is celebrated in September. The first snow thaw in place. Stable snow cover is formed in late October and early November. Due to low winter temperatures and high summer, annual amplitudes in Central Yakutia reach record highs, as nowhere in the world. Average air amplitudes in Yakutsk are 62° C, and absolute 100° C and more. Thus, the climate of Yakutsk is a favorable condition for specific industries requiring various works in winter.

Currently, winter car tires in the world are tested at PGs located in New Zealand, Finland, Sweden, Canada, the United States (Alaska), Norway, etc.

Table 1. Comparative analysis of the climate of the northern territories for 2010-2016.

Statement	Yakutsk, Russia	Wanaka, New Zealand	Ivalo, Finland	Sweden	Canada	Alaska, USA	Norway
Average annual temperature, °C	-10.2	+10.3	-0.9	-2.2	-4.6	-2.9	-1.3
Average min temperature, °C	-44.0	-12.0	-19.0	-20.0	-30.0	-33.0	-17.0
Average max temperature, °C	+30.0	+25.0	+22.0	+24.0	+25.0	+25.0	+20.0
Max amount of snow in 1 quarter of 2016, cm	7.4	3.3	17.5	24.2	18.5	8.0	13.1

According to the data presented in Table 1, the city of Yakutsk has the lowest average annual temperature (-10.2°C) and the average minimum temperature (in the period 2010-2016 -44°C). Unlike Yakutsk, the climate in the countries under consideration is not characterized by sharp temperature changes, the average annual temperature is from -4.6°C to 10.3°C .

In 2016, the maximum amount of snow falling during the quarter in Yakutsk was 7.4 cm. The largest amount of snow precipitation is observed in Sweden, Finland, Canada and Alaska.

In addition, another of the features of the climate of Yakutsk is the presence of permafrost soils.

**Figure 1.** Permafrost distribution in Nordic territories.

It follows from Figure 1 that the largest area of perennial permafrost is in Russia (60-65% of the country's area), including the territory of the Far East, in particular the Republic of Sakha (Yakutia).

One of the Earth's key environmental problems today is global warming. Global warming is an increase in the average temperature of the Earth's climate system. The average near-surface air temperature for the period 1906-2005 rose by $0,74 \pm 0.18^\circ\text{C}$. The rate of warming during the second half of this period is about double that for the period as a whole.

There is an acceleration of permafrost degradation. Since the early 1970s, the temperature of long-term frozen soils in Western Siberia has increased by 1.0°C , in central Yakutia - by $1-1.5^\circ\text{C}$. At the same time, compared to other countries, this figure is not as high as in northern Alaska, where the temperature of the upper layer of frozen rocks has increased by 3°C since the mid-1980s.

Despite global warming trends, the maximum annual temperature in Yakutsk fell from 29°C in 2010 to 22°C in 2016 (Figure 2). In all other countries under consideration, this indicator increased in contrast over the period 2010-2016. The largest increase is in Wanaka, New Zealand, from 20°C to 25°C .

Relative to the minimum annual temperature in Yakutsk, Vanaka and Ivalo, its stable level and average value for 2010-2016 are -40.3°C , -5.4°C and -16°C , respectively. In Canada, the minimum annual temperature dropped from -18°C in 2010 to -28°C in 2016 (Figure 2).

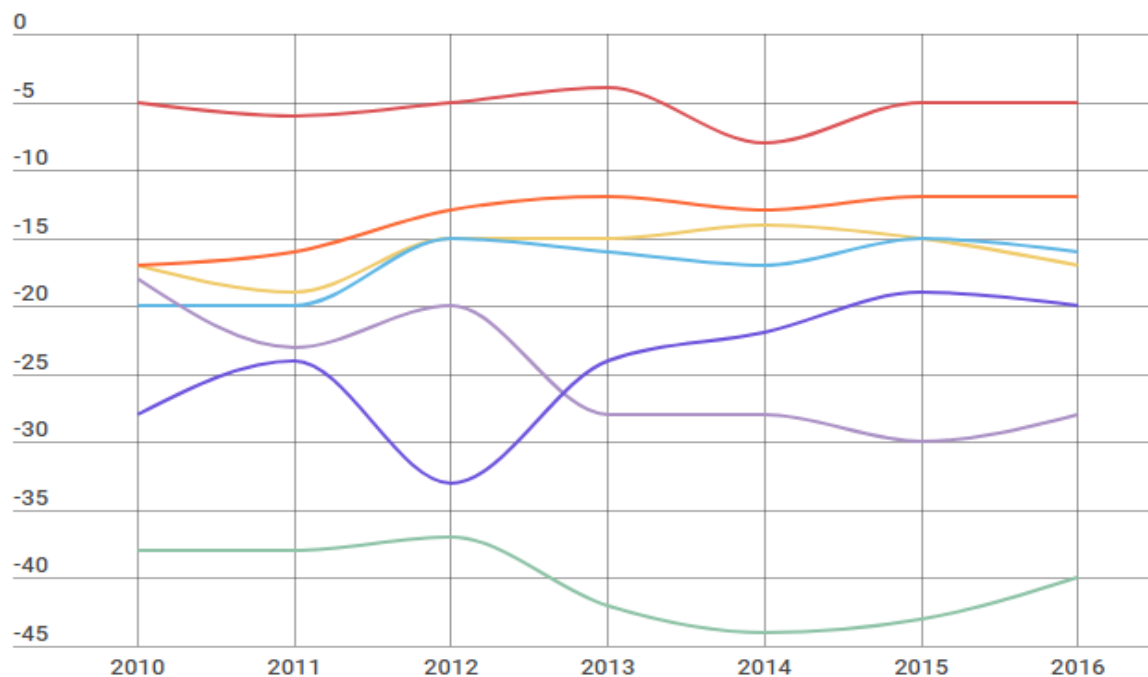


Figure 2. Dynamics of minimum annual temperatures for 2010-2016, $^\circ\text{C}$.

Table 2. Season duration for tire testing and average monthly temperatures in 2016, $^\circ\text{C}$.

PG	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Yakutsk, Russia	-36	-36	-15	-1	+9	+18	+19	+15	+9	-6	-24	-32
Vanaka, New Zealand	+16	+19	+14	+11	+6	+4	+2	+3	+8	+10	+11	+14
Ivalo, Finland	-16	-7	-4	+1	+10	+13	+17	+13	+9	+3	-5	-6
Sweden	-15	-9	-4	0	+9	+11	+15	+11	+9	+1	-8	-7
Canada	-19	-23	-14	-7	+9	+16	+19	+16	+8	-1	-5	-19
Alaska, USA	-13	-11	-9	+5	+14	+19	+19	+17	+9	-1	-13	-18
Norway	-11	-6	-2	+3	+10	+10	+15	+12	+10	+3	-3	-2

Table 3. Information on potential customers of the PG - manufacturers of winter automobile tires.

Manufacturer	Headquarters	Interest in Yakutsk PG	
		Location	Climate
Bridgestone	Tokyo, Japan	+	+
Michelin	Clermont-Ferrante, France	-	+
Continental	Hannover, Germany	-	+
Hankook Tire	Seoul, South Korea	+	+
Nokian	Nokia, Finland	-	+
Toyo	Osaka, Japan	+	+
Yokohama	Tokyo, Japan	+	+
Dunlop	Akron, Ohio, USA	-	+

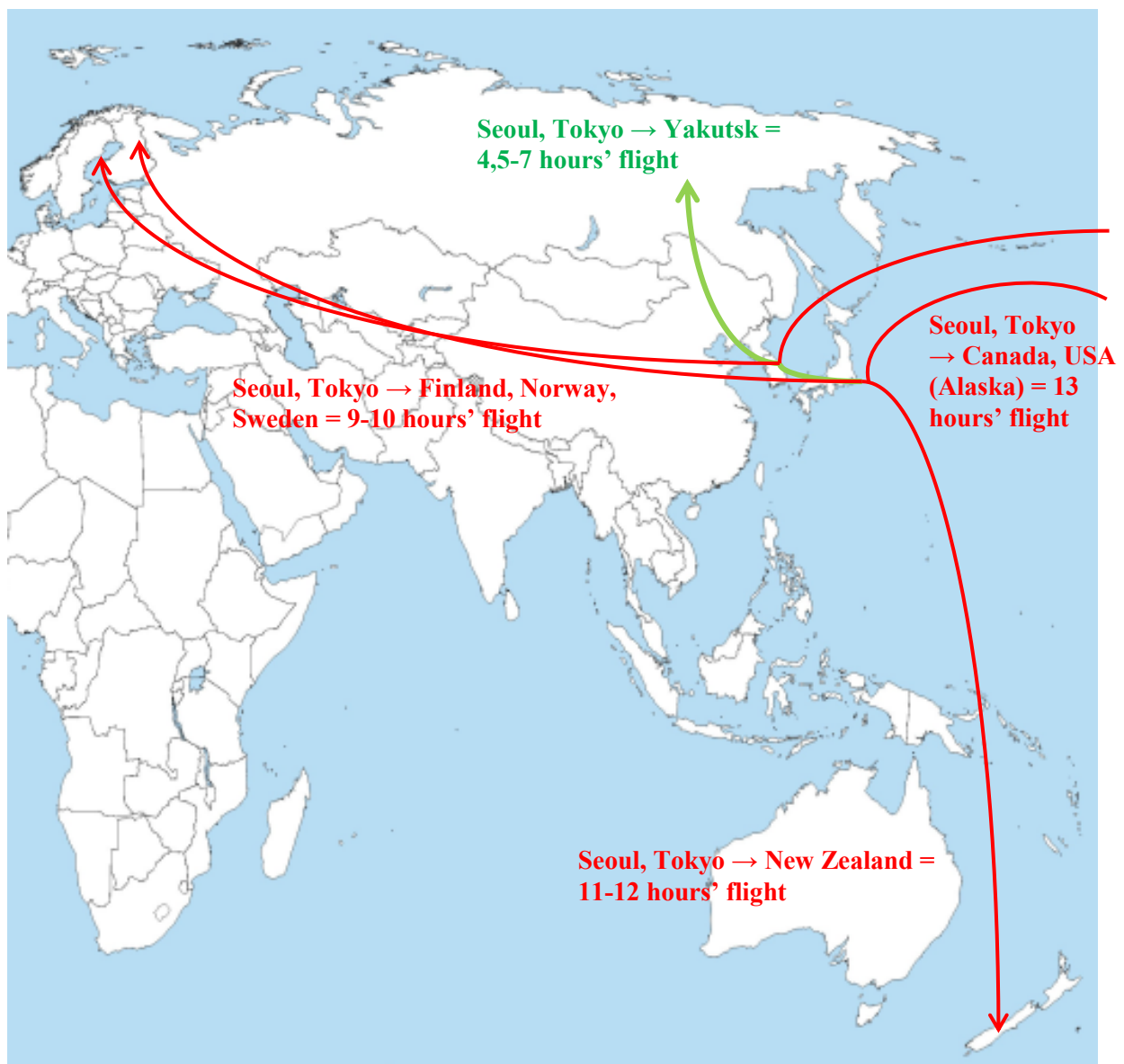


Figure 3. Advantages of Yakutsk PG location for Japanese and Korean tire manufacturers.

In addition to climatic Yakutsk PG advantages can certainly be attributed to the advantageous geographical location and logistics, which is important for Asian tire manufacturers; Attractive investment climate in the form of a favorable exchange rate of the national currency and ASEZ preferences, which allow to maintain flexible price client policy and reduce operational costs.

5. Practical relevance, suggestions and results

At the present stage, the PG is a complex of automobile routes, including straight and curved closed tracks from 80 to 1800 meters long with a band width from 5 to 30 meters with ice and snow coating in winter. The structure of the NEFU Proving Ground complex (option basic) included the following objects: proving ground (place 1 "PG"), heavy machines garage (place 2 "Kapitonovka"), technical center (place 1 "PG"), center of customer service (place 2 "Kapitonovka"). The main activity on technical tests of machines, automobile tires and equipment is deployed on the PG place. Full-scale tests of road materials, assemblies and equipment of machines are planned on the territory of Kapitonovka.

According to the approved plans, the prospects for the PG development are related to technical tests and research activities in the following areas:

1. Complex ground tests of amphibious aircraft La-8, Arctic-1 aircraft, including: research and development; experimental studies; factory finishing and acceptance tests, experimental-industrial operation.
2. Full-scale tests of power plants, components and equipment on existing aircraft, including An-2.
3. Bench tests of rubber-technical products and road pavements with monitoring.
4. Tests of stability and strength of structural layers of airfield coatings with selection of compositions.

6. Conclusion

The identified automobile tires PG advantages in ASEZ "Industrial Park "Kangalassy" of the Republic of Sakha (Yakutia) over competitors are:

1. Season duration for testing.
2. Favorable climatic conditions: low temperatures, permafrost, natural snow.
3. Transport availability of the PG for Asian manufacturers and, as a result, cost reduction.

Thus, the key advantages of the Yakutsk PG lead to a growing interest in the activities of the existing automobile tire PG by manufacturers of machines, equipment and materials, which becomes a natural and harmonious continuation for the creation of conditions for the further PG development and the formation of a unique universal world-class test center in the Arctic part of the Russian Far East.

The project has the following benefits for the parties involved:

1. Far East region of Russia
 - Attracting direct investment, including foreign investments;
 - Increasing investment attractiveness of the Far East region and the country;
 - Growth of tax revenues to the budget system;
 - Creation of conditions for sustainable socio-economic development of the region and improvement of the quality of life of the local population
2. Republic of Sakha (Yakutia)/city of Yakutsk
 - Development of urban areas and increase of investment attractiveness of the Republic, Yakutsk and Kangalassy;
 - Increased international cooperation;
 - Tax revenues to the regional and local budgets.
3. Kangalassy settlement
 - Growth of local community business activity;
 - Creation of new jobs (32);
 - Increasing income and improving the quality of life of the local population.
4. NEFU

- Strengthening of business reputation;
- Expansion of educational and scientific infrastructure and range of scientific research in the field of materials science, frost science and climatology.

5. Potential Customers – Manufacturers

- Access to an object with unique characteristics, such as a wide range of temperatures, quality of natural snow, permafrost;
- Improvement of the logistics scheme for the delivery of tires and equipment, respectively, reduction of transport costs for manufacturers of materials, equipment in the Asia-Pacific region.

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