

Distinctive Features of Human Adaptation to the Environment of the Arctic Zone of the Republic of Sakha (Yakutia)

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Abstract

The paper gives a medico-geographical analysis of various Arctic and sub-Arctic regions of Yakutia, namely, the city of Yakutsk, the town of Nam of Namsky District and the rural town of Tiksi of Bulunsky District. A new methodological approach and methods are suggested for assessing the adaptation process of residents of Russia's Eastern Arctic using the medico-ecological screening of the population. This procedure found the general adaptation syndrome among the residents of Yakutia's sub-Arctic and Arctic areas. A survey was used to investigate the impacts of different environmental factors on adaptation indicators among various groups residing in some of Yakutia's districts. Adaptation parameters were defined among indigenous and non-indigenous groups living in various Arctic areas in terms of extreme environmental conditions affecting human adaptation to changing environments.

Key-words: Human Adaptation, Environmental Factors, Medical and Geographical Research, Health of Indigenous and Non-indigenous People, Arctic and Sub-Arctic Regions of the Republic of Sakha (Yakutia).

1. Introduction

The rapid development of the northern regions of the Russian Far East implies further theoretical and methodological research into regional human ecosystems, thematic mapping and forecasting activities and the definition of the place and role of the man/environment relationship in the entire system of social and economic development of northern territories [1-3]. Multiple factors in the lifestyle of people residing in northern territories as well as their mediated and untraceable impacts on the functioning of the human body in northern climate conditions require the elaboration

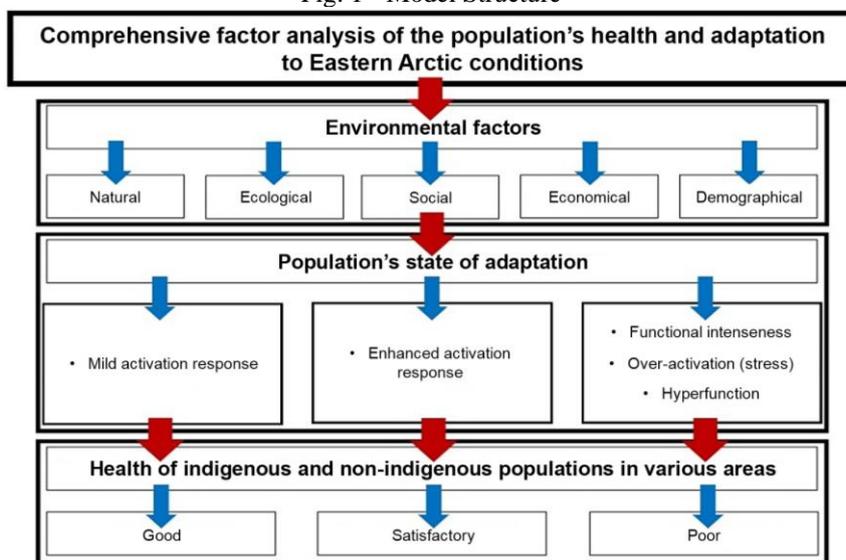
of new approaches to the quantitative and qualitative assessment of how various groups living in the Russian Eastern Arctic (REA) adapt to changing geopolitical, socio-economic, ecological and natural environments [4].

A quick survey of research studies on Northern populations' problems of adaptation reveals their multidimensional and relevant nature and current research focus on spatial development highlighting the need for the population to adapt to the Arctic's changing conditions [5-8]. The world's Arctic regions are extremely attractive due to their diversified and rich natural resources [9-12] and, specifically, the arctic zone of the Russian Far East is unique in terms of minerals and raw materials, with over 1,100 solid mineral deposits.

Nonetheless, most eastern Arctic and sub-Arctic regions have not been sufficiently examined and require more in-depth and comprehensive research [13], the number of targeted medico-geographical studies on the territory under investigation being very low [14]. No comprehensive assessment is available of adaptation processes among northern populations, limiting an accurate estimation of the quantitative and qualitative variability of northern population's adaptation profile. Therefore, the available empirical and experimental data cannot be used to set out guidelines for applying practical methods aimed at improving northern residents' medical, biological, psychological and social sustainability [15].

The absence of reliable criteria for determining the adaptation capacity and health of a population as well as the regional and local specificities of life in the Eastern Arctic explain the need to produce a conceptual model showing the adaptation of Yakutia's population to the changing environmental factors (Fig. 1).

Fig. 1 - Model Structure



The above model comprises the following units of indicators: environmental, individual health and public health factors. The component-wise analysis of the model's functioning scenarios detects previously unknown relationships in the population/environment system. The study of specific aspects of human adaptation in Russia's Arctic and sub-Arctic regions, including the Far East, involved investigation of various risks, health problems and manifestation of pathologies [8]. This being said, the issue of adaptation concerns a much wider range of factors (such as employment, morbidity, death rate, population exodus, migrations, life expectancy and so on), influenced by a combination of changing environmental (natural, ecological, economical and social) factors.

To assess the health of populations exposed to the Russian Eastern Arctic's harsh conditions, research seems particularly relevant on the possibilities and acceptable forms of adaptations of various populations to the changing Arctic conditions. Studying specificities of the Northerners' adaptation to extreme conditions has gained in significance and is becoming a major part of population monitoring. Additionally, the classification of the adaptive portraits of people inhabiting regions with extreme climate conditions is currently seen as one of the primary tasks of medico-geographical research.

The **goal of research** is to examine the spatial differentiation in terms of levels and forms of adaptation of various groups to changes in environmental conditions taking place in a number of areas in the Republic of Sakha (Yakutia).

2. Materials and Methods

The development of the current state of adaptation to changing environmental conditions among indigenous and non-indigenous groups residing in three regions of Yakutia was assessed using the rapid diagnostic test conducted on ROFES, a hard- and software tool for electro puncture diagnostics of the human body's functional status [16]. To this end, the population of the city of Yakutsk, the town of Nam of Namsky District and the rural town of Tiksi of Bulunsky District were subjected to a medico-ecological screening determining the general adaptation syndrome among the Arctic and sub-Arctic population examined. The individual characteristics of the disadaptation syndrome were studied as part of the screening. Groups susceptible to environmental factors and prone to specific disadaptation disorders were detected. These disorders manifest themselves as pre-nosological states, namely, psychological, emotional and physiological disturbances resulting in various diseases [17].

The survey involved 112 indigenous and non-indigenous people (Table 1). Among non-indigenous people are settlers from different regions of the former USSR (Russians, Ukrainians, Belarusians, etc.) whose adaptation mechanisms for surviving in polar altitudes are weaker than those of indigenous people. The extent of adaptation processes was specified; various adaptation disorders were described quantitatively and qualitatively; and the outcomes were assessed in terms of clinical medicine and psychology.

Methodologically, the study is based on two interconnected sources of information on human adaptation in the North: 1) recorded quantitative indicators of public and individual health of residents, and 2) fundamental neurophysiological developments, i.e. the updated theory of stress and Selye's general adaptation syndrome.

Table 1 - Distribution of People Examined by Locality as Part of the 2019 Study

Locality	Men	Women	Non-indigenous groups		Indigenous peoples of the North	
			men	women	men	women
Yakutsk	11	29	2	9	9	20
Nam (Namsky District)	6	15	1	1	5	14
Tiksi (Bulunsky District)	14	37	4	14	10	23
Subtotal	31	81	7	24	24	57
Total	112		31		81	

Recording of psychophysiological parameters underlying human adaptation to the changing environmental conditions detected the following stages in the development of human adaptation levels: stress, sub-stress, adaptive response and training, among others; and the following adaptation states: satisfactory adaptation, pre-nosological state and premorbid state. The accumulation of empirical data on individual responses and their conversion to statistically homogenous groups introduced the category of 'adaptive potential' into scientific discourse, which refers to the population's grouping by gender, age, territory, profession, social or other status [18].

In this methodological approach, the study of northern populations' adaptation/disadaptation involves an assessment of the Northerners' group – and, to a lesser degree, individual – adaptive responses to the impact of adverse environmental conditions of varying intensity and duration. To investigate the adaptation of different groups residing in specific Arctic and sub-Arctic regions, fieldwork and statistical research on the medical, geographical and ecological conditions of these areas was carried out, and screening-based laboratory research on the levels of indigenous and non-indigenous population's adaptation was done using the ROFES testing. The local population was examined with a view to determining human comfort in the territories under investigation. A study was done on the impact of environmental factors on the indicators of various groups' adaptation and

health indicators. A medico-geographical assessment was done of external environmental factors affecting human adaptation to changing environments.

The cohort method of recording skin's bio capacity in tender zones and in active acupuncture points was used to assess human adaptation processes to the Far North's harsh conditions. ROFES, a hardware and software electronic device, was used to carry out the examination for the purposes of ecological monitoring.

3. Results

A survey was conducted among the REA's residents to study the impact of natural, ecological and socio-psychological ways of life (habits, attitudes towards smoking, alcohol, eating habits, physical activity, etc.) on the human adaptation status. The survey provided for the clearly territorial pattern of a survey unit as opposed to public administrative statistics, for instance, the disease rate, permitting the identification of previously unknown disease-related natural and social risk factors. In addition to direct questions about a person's medical condition, job-related, household and family factors, the survey for adults included questions on their lifestyle, specifically professional and social activity, working hours, leisure and so on. In some instances, the survey was complemented with data obtained from medical documentation. The conducted survey took into consideration the impact of another major factor, i.e. high migration rates, on the Northern population's adaptation state. The responses of indigenous people were analyzed separately from those of non-indigenous respondents residing in the region both less and more than five years.

The results of the fieldwork carried out among particular groups living in Sakha (Yakutia), including questionnaires, are ambiguous and even contradictory (Table 2). The total number of respondents is 40 in the city of Yakutsk, 21 in the town of Nam (Namsky District) and 51 in the rural town of Tiksi.

Table 2 - Survey Results on Sakha (Yakutia) Population

Sakha (Yakutia) Localities	Potable water*, % of respondents				Quality of potable water (person)			Living conditions, % of residents			Living condition factors** (person)		
	1	2	3	4	good	satisf.	poor	satisf.	poor	bad	a	b	c
Yakutsk	27.5	45.0	15.0	12.5	6	24	10	72.5	20	7.5	2	34	4
Nam (Namsky District)	0	23.8	76.2	0	0	4	17	80.9	14.2	4.9	4	16	1
Tiksi	49.0	5.9	2.9	41.2	11	25	15	70.6	27.4	2.0	12	34	5

*1-filtered, 2-bottled, 3-ice, 4-boiled tap water;

**bad living conditions: a-natural, b-anthropogenic, c-no impact

Most of the respondents in Yakutsk and Tiksi point to the unsatisfactory water quality and prefer using filtered or bottled water. The residents of Nam favor ice water (frozen river water), considered crystal-clear. Ice water is also in favor among the residents of Yakutsk and Tiksi. On the other hand, the survey reveals that most residents of these localities suffer from gastro-intestinal disorders (Yakutsk, 55%; Tiksi, 70.6%; and Nam, 52.4%). An analysis of the survey results among indigenous and non-indigenous respondents shows that the incidence of a number of diseases is higher among the indigenous population (Table 3), which is particularly evident in Yakutsk. This incidence is lower in Tiksi, and only indigenous people were examined in the district center of Nam.

Table 3 - Morbidity Pattern of the Population Examined, %

Classes of disease	Yakutsk		Nam (Namsky District)		Tiksi (Bulunsky District)	
	population					
	indigenous	non-indigenous	indigenous	non-indigenous	indigenous	non-indigenous
Gastro-intestinal diseases, %	42.8	17.4	70	0	59.3	49.4
Respiratory diseases, %	21.4	13	25	0	21.8	15.7
Cardiovascular diseases, %	25	47.8	35	0	62.5	52.6
Colds (survey results), %	21.4	8.7	5	0	40.6	42.1
Total, person	28	23	20	1	32	19

Most water resources in Sakha (Yakutia), notably rivers and lakes, are classified as dirty. These include Lena, Omoloy and Aldan rivers, Melkoye Lake, Tiksi Bay (mineralized seawater), among others, in which many elements exceed maximum admissible concentrations, or MACs (Table 4). This is probably due to low temperatures and the slow sedimentation and decomposition of pollutants in rivers [19-22]. Besides, water-supplying surface water bodies do not meet chemical and bacteriological sanitary rules and regulations.

Table 4 - Exceeded MAC Values at Check Points

Components	Yakutsk	Nam
chemical oxygen consumption	<MAC	1.1
carbolic acids	<MAC	1,1
iron	1.5	<MAC
copper	1.8	3.0
manganese	8.7	14.7
sulfates	<MAC	<MAC

Further exploration of the REA having great economic potential is closely related to the issue of human adaptation, mostly focused on studying the functioning of the human body's psychophysiological systems in harsh climatic and ecological conditions. The authors have examined the specificities of the adaptive processes of the REA's inhabitants that are currently shaping the adaptive profiles and health levels of indigenous and non-indigenous residents. Respondents in three regions in Yakutia, namely Bulunsky and Namsky Districts and the city of Yakutsk, were subjected to the medico-ecological screening, identifying the general adaptation syndrome among the screened residents. The screening studied the individual manifestations of the disadaptation syndrome and identified groups of people susceptible to the impact of environmental factors and prone to disadaptive disorders that cause various diseases.

The adaptive psychological and emotional capacity of the indigenous and non-indigenous population of Yakutia's northern areas was specified. A unique combination of factors proper to Arctic territories develops a functionally unstable state of higher nervous activity among a significant portion of the population. The farther north, the more frequent and severe mental disorders. As an individual's personal anxiety increases, his or her potential adaptive capacity decreases.

The following integral characteristic was used to assess an individual's functional state and the readiness of human adaptive mechanisms to develop his or her adaptive functions to different (geographical, industrial, ecological or social) conditions: Adaptive Capacity (AC) relates to the human condition resulting from stress generating environmental factors which emerge from combined physiological and psychological adaptive responses (Table 5).

The research outcomes reveal that the number of people with high levels of AC was higher in the city of Yakutsk (53.8%) as compared to the Arctic town of Tiksi (45.1%). Interestingly, these figures are higher among the indigenous population as opposed to non-indigenous residents in both Yakutsk and Tiksi. This attests to a longer formation and a higher level of adaptive responses among the region's indigenous population to the environment in contrast to the non-indigenous/European population. Harsher living conditions in the Arctic town of Tiksi decrease the AP among both indigenous and non-indigenous people.

In addition to natural, social and ecological factors, mental and emotional overloads in the North result in disruptions of the human body's adaptive responses.

Table 5 - Levels of Adaptive Capacity (AC) of Groups Residing in different Arctic and Sub-Arctic Localities of the Republic of Sakha (Yakutia)

Groups	Total number of persons	Number of persons with high levels of AC (% of those examined by region)			Number of persons with low levels of AC (% of those examined by region)		
		Mixed group	Non-indigenous population	Indigenous population	Mixed group	Non-indigenous population	Indigenous population
Yakutsk	39	53.8	23.1	30.8	46.2	18	28.2
Tiksi	51	45.1	19.6	25.5	54.9	17.6	37.3

Risk factors for human disadaptation are, at the same time, risk factors of developing diseases, given that the latter result from the disruption of homeostasis. Diseases develop gradually from pre-nosological states into premorbid ones, which are typical of the so-called third state of health (pre-existing disease), and then into nosological states/diseases (Table 6). All states of disadaptation are significantly higher among Yakutia's indigenous people as compared to non-indigenous residents.

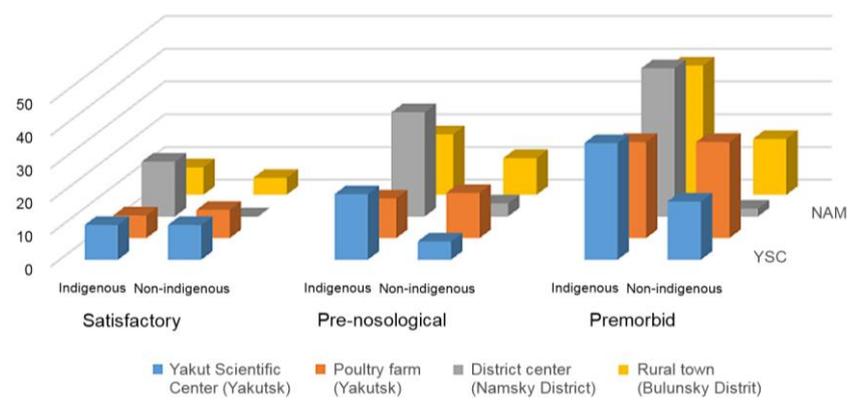
Table 6 - Mental and Emotional Disorders of the REA's Residents (Yakutia)

Adaptation levels	Non-indigenous population		Indigenous population	
	Number of symptoms	%	Number of symptoms	%
Satisfactory adaptation (mild activation)	39	6	68	10.5
Pre-nosological state (enhanced activation)	55	8.5	136	20.9
Premorbid state (stress)	101	15.5	251	38.6

A number of criteria for the 'structure of health' showing the share of persons with various levels of adaptation to the environment were used to assess mental and emotional disruptions among Yakutia's groups of indigenous and non-indigenous residents, resulting in the following (Fig. 2). Considering all the identified mental and emotional disorders, 38.6% of respondents were revealed to be in the premorbid state or in stress/functional intenseness and 20.9% in the pre-nosological state/enhanced activation showing a prolonged intenseness of human adaptive capacities. This is typical of the emergence, among the population, of new levels of adaptation to the ever-changing environmental conditions or disrupted adaptation.

The adaptive physiological capacity of the organs and systems of indigenous and non-indigenous residents of Yakutia's northern regions was assessed in the city of Yakutsk, the urban town of Tiksi and Namsky District. In Yakutsk, 51.5% of the examined residents were indigenous (Yakuts, Evenks and Nenets), of which 27.5% and 72.5% were men and women respectively.

Fig. 2 - Adaptive States of different Groups of Residents



Men showed enhanced activation response (52.2%) whereas women had mild activation (58.6%). Stress adaptation responses, however, were recorded in 12.5% of cases, 1.4% times more among women than among men. Mild activation response prevailed among the indigenous residents of Yakutsk (58.2%), its share being twice as high as among the non-indigenous residents (29.8%). By contrast, enhanced activation response prevailed among the non-indigenous residents of Yakutsk (52.4%), which is 4.5 times higher than the among indigenous residents (11.5%) (Table 7).

Table 7 - Adaptation Responses of Yakutia's Indigenous and Non-indigenous Residents,%

Adaptation response	Yakutsk		Namsky District		Tiksi	
	Indigenous population	Non-indigenous population	Indigenous population	Non-indigenous population	Indigenous population	Non-indigenous population
Mild activation	58.2	29.8	72.3	31.6	48.3	32.4
Enhanced activation	11.5	52.4	21.5	44.6	53.2	62.5

In Namsky District, 95% of the examined residents were Yakuts, of which 25% and 75% were men and women respectively. Most men (59.1%) showed enhanced activation response whereas 58.1% of women had mild response. However, 41.9% of Yakut women were over-activated (stressed), with no such cases recorded among men. The over-activation response was mostly due to stressed regulatory functions in the lower parts of the stomach and hyperactivity in the meridians responsible for gastrointestinal functions. Mild activation response prevailed among the indigenous residents of Namsky District (72.3%), its share being 2.3 times as high as that of non-indigenous residents (31.6%). Enhanced activation response prevailed among the non-indigenous residents of Namsky District (44.6%), which is 2.0 times higher than among the indigenous residents (21.5%).

Women (61.4%) prevailed among the examined residents of Tiksi, and 62.7% of the total number of the examined were Yakuts. 64.3% and 58.3% of men and women respectively showed enhanced activation response. Men manifested functional activity response twice as often as women, 15.2% and 8.0% respectively. 1% of both men and women showed stress response, and 93% of stress hyper-reaction were detected among the non-indigenous residents having a direct bearing on the digestive organs, mostly, on the different parts of the stomach. Mild activation response prevailed among the indigenous residents of Tiksi (48.3%), its share being 1.5 times as high as that of the non-indigenous residents (32.4%). Enhanced activation response prevailed among the non-indigenous residents of Tiksi (53.2%), which is 1.1 times higher than among the indigenous residents (48.3%).

4. Discussion

The ROFES diagnostic test assesses the human body's capacity to demonstrate qualities of modification variability in response to external stressors. The ROFES tool comprises three levels of human state as a complex functional system: 1) phenomenology of electro-acupuncture diagnosis; 2) invariant models for defining an individual's general adaptation syndrome; and 3) current perceptions of biophysical human characteristics as consistent ecological monitoring and bio-indication indicators.

The structural and functional analysis of general adaptation syndrome according to the ROFES diagnostic method allows for assessment of the specific and non-specific component of the general adaptation syndrome among the examined. The medical and psychological part of the analysis, focused on the non-specific aspects of the general adaptation syndrome, makes it possible to carry out a screening diagnosis of the disadaptation syndrome, detect the weak link within the structure of the human body's general adaptation syndrome and determine a person's individual susceptibility to a specific type of disadaptive disorders. The ecological part of the analysis specifies the nature of the stressor affecting the organism of an individual/group of people and activating their adaptation responses. A combination of specific and non-specific approaches to interpret the ROFES test results within the same device allows for comparison, on a single scale, of the body's response to various types of stressors, namely, to chemical, physical and social ones [16].

Cardiovascular diseases prevail among the examined non-indigenous residents of Yakutsk, whereas indigenous residents of all other localities under study lead in other groups of diseases.

In our view, this situation may be explained as follows. Only recently has the indigenous population begun to be negatively affected by human impacts on the environment (contaminated air,

water, including ice water, polluted biological resources, changing food systems, etc.) in comparison to non-indigenous residents who migrated from areas where the human organism had adapted to negative environmental impacts. The non-indigenous population's *passionarity* may also contribute to lower morbidity among non-indigenous residents as compared to indigenous ones. Allergies, mostly cold allergies, account for a significant share of diseases.

The formation of the chemical composition of river waters is affected by geographical conditions (continental climate, lengthy freeze-up, permafrost and low self-cleaning) and hydrological conditions, yet the bulk of it consists of untreated wastewater discharges by public enterprises and housing and communal services. The survey results confirm this fact, given that most of the respondents consider human factors as the main reasons behind unsatisfactory living conditions.

The hydro-chemical water quality of the Lena River is subject to seasonal fluctuations depending on the river's hydrology. During the summertime decrease of the water level in the Lena River, the lead, iron and oxidation-resistant organic concentrations (according to the Economic Procedure Code, or EPC) are 2.9, 1.5 and 1.6 times up the normal level, respectively. The ammonium ion concentration, with 1.2 of MACs, is slightly above the normal at almost all of the checkpoints. The copper concentration increases from 2.6 to 2.8 of MACs, with the EPC indicator going up to 2.7 of MACs, downstream from Yakutsk to the town of Kangalassy. The zinc concentration is exceeded to 1.3 of MACs in the vicinity of Nam. The unsatisfactory situation with wastewater treatment leads to a considerable increase of pollutants in coastal waters that are of major significance as fisheries. For instance, Tiksi Bay is an important fishery in which the concentration of the following substances exceeds environmental standards: phenols (3.3 times), manganese (3.3 times), copper (1.4 times), iron (5.6 times) and strontium (1.2 times).

Furthermore, oil plants, fuel and lubricant warehouses, diesel engine rooms, garages and accidents on oil pipelines also pollute water basins. Other pollutants include wastewaters from mines and open pits, characterized by muddiness and high concentrations of chemical and bacterial pollutants. Despite significant reserves of surface water and groundwater, two thirds of the population have access to only decentralized water supply due to the lack of water treatment facilities and systems. Wastewater is discharged directly into rivers, lakes and seas, most rivers have a small capacity to self-clean their waters, and decomposition processes are almost inexistent under the ice of rivers and seas. Consequently, the ice water consumed by the population appears to be one of the sources of gastrointestinal diseases.

Since the region's prospects for further development, i.e. major investment projects, are mainly related to mining activities, changes are possible in the structural and spatial aspects of natural resource use [23]. As there are no large-scale investment projects in environmental protection and management, no changes in this field are envisaged for the time being, which will inevitably result in a negative impact of human activity on the environment and destabilize ecology. The natural and climatic conditions aggravate human impacts on the environment in the area considered. Currently, nothing is being done to improve environmental protection, meaning that the existing ecological and social issues coupled with human impacts on the environment will have a negative effect on the population's living conditions.

The region under study is exposed to a growing human impact on the environment, and its negative medical and ecological situation is attracting close public attention. The ongoing climatic and ecological changes in northern residential localities need a thorough review in terms of the entire region and its distinct areas. Such a review is of considerable complexity due, on one hand, to the territory's vastness and low population density and, on the other, to a great variety of its natural, anthropogenic, socio-economic, ethnic, infrastructural and social facilities as well as to its transport and logistics specificities.

The authors have studied the adaptive processes of residents of the REA and the sub-Arctic Zone, which are currently shaping the adaptive profiles and health levels of the indigenous and non-indigenous population. Long-term residence in the harsh climatic and geographical conditions of the North strains all the adaptive reserves of the human body.

Historically, the indigenous population of the North managed to adapt well to the environmental factors, yet in our days their health status is lower than that of the non-indigenous population. This contradiction is due to the current lifestyle of the indigenous minorities of the North, low levels of education and culture and the presence of numerous natural, medical and biological risk factors, such as frequent consanguineous marriages leading to high rates of congenital anomalies and serious birth defects.

Our study of the adaptive responses among indigenous and non-indigenous residents of the Far North has revealed the following. As a whole, mild activation responses prevailed among Yakutia's indigenous population, ranging from 48.3% in Tiksi to 72.3% in Namsky District. On the contrary, enhanced activation responses prevailed among non-indigenous residents, ranging between 44.6% in Namsky District to 62.55% in Tiksi. Therefore, a greater functional tension of various organs and systems characterizes the adaptation responses of the non-indigenous population.

Evaluations of organs and systems under stress revealed that enhanced activation and functional tension in the digestive system are typical of both indigenous and non-indigenous residents. Mostly mild and enhanced activation characterized the functional state of the examined residents' respiratory system, yet the small number of observations makes it impossible to consider this fact as statistically important and requires further research.

Consequently, residents of Russia's northern regions show mostly compensatory responses preconditioning enhanced activation of the functions of the central and peripheral nervous system. The intenseness of men's adaptive mechanisms is more strongly pronounced than that of women, which can be explained by lower functional reserves of men's bodies and higher physical activity related to their professional life.

With the arrival of non-indigenous residents in the Far North, ecological, economic and socio-hygienic factors, which changed for the worse the first nation's adaptation mold, have become of paramount importance in the development of demographic processes and morbidity. The population's disadaptation processes on the mental and emotional level have been more active among the indigenous population of the regions under study than among non-indigenous residents (Fig. 2), which points to northern indigenous people's heightened sensitivity to the emergence and rapid progression of unfamiliar and negative environmental changes. Currently, the health of indigenous peoples is worsening due to disruptions in the biological and functional processes occurring in the human organism, changes in the socio-professional structure, food habits and socio-cultural and ethnic rhythms.

The adaptation responses of non-indigenous residents on the physiological level are characterized by a greater functional intenseness of their organs and systems in comparison to the indigenous population, suggesting that the latter's physiological adaptation mechanisms are more resistant to changing environmental conditions. Consequently, if these conditions deteriorate, the first to react are the mental and emotional adaptation mechanisms followed by physiological ones, which can further lead – in case of prolonged exposure to stressors – to failed adaptation and the emergence of diseases.

An evaluation of various organs and systems under stress reveals prevalence of enhanced activation and functional intenseness in the gastrointestinal organs of both non-indigenous and indigenous residents. Interestingly, in contrast with previous research, gastrointestinal organs have been revealed to be more at risk than respiratory ones.

In view of the above, it is possible to detect territories that are most likely to confront ecological and social problems. These are Anabarsky, Bulunsky and Ust-Yansky Districts. Currently,

human activity is considerable in these areas, and there are plans to further develop economic activities having a negative effect on the environment.

5. Conclusion

Consequently,

1. The ecological environment of the Arctic North of the Russian Far East is currently satisfactory, with the exception of Anabarsky, Bulunsky and Ust-Yansky Districts in Sakha (Yakutia).
2. The population of the territories under study shows mostly compensatory responses preconditioning enhanced activation of the functions of the central and peripheral nervous system. The intensity of men's adaptive mechanisms is more strongly pronounced than that of women, which can be explained by lower functional reserves of men's bodies and higher physical activity related to their professional life.
3. The results of the survey carried out among particular groups living in Sakha (Yakutia), including questionnaires, are ambiguous and even contradictory, especially in terms of evaluating factors associated with the standard of living.
4. The population's preference for drinking ice water is erroneous, as evidenced by a high rate of gastrointestinal diseases among the examined.
5. Traditional economic activities prevail in Sakha (Yakutia), excluding Anbarsky and Ust-Yansky Districts.
6. The water of major rivers in Sakha (Yakutia) are classified as dirty.
7. Proposed changes in environmental management will mostly affect industrial and transportation sectors.

While offering great potential for further development and investment attractiveness, the territories under investigation are exposed to major risks relating to local environmental conditions, global ecological issues (global warming, thawing of permafrost, etc.) [24] and the current economic situation. If implemented, the projected economic activity will lead to undesirable changes in natural resource management to the point of causing irreversible consequences and significant damage to the population's life sustenance. This is why short-term measures should be taken to promote the environmental, and not the industrial, aspect of natural resource management. Such measures include the following:

1. Measures intended to revitalize territories exposed to human activity: restoration of damaged soils; removal of metal and other hazardous industrial waste and illegal dumps from territories; development and implementation of environment-oriented and resource-saving projects; solid and broad State support for and maintenance of traditional economic activities.
2. Measures intended to build, in compliance with Sanitary Rules and Regulations, new water supply and discharge facilities and waste recycling plants, or to reconstruct old ones (if any).

Effective implementation of the above measures requires engagement, active commitment and real support on the part of State and regional authorities, introduction of tax deductions and other incentives for the restoration, preservation and the economically substantiated and environmentally acceptable development of the Arctic territories of the Russian Far East.

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Authors' Contribution

S.A. Lozovskaya: statement of the problem, collection of data, testing, partial analysis of the results and preparation of the handwritten draft.

N.G. Stepanko: collection of data, testing, partial analysis of the results and writing of the final version of the paper.

A.B. Kosolapov: partial analysis of the results and proofreading.

We have no conflicts of interest to disclose.

All authors have approved the submission of this manuscript.

The results have not been previously published and are not being considered for publication in another journal.

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