Comparative Analysis of Living Conditions and Environmental Factors Related to the Population Demography, Well-being and Health in Urban and Rural Areas of Nenets Autonomous Okrug (Arctic Russia): 2000-2019

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The present review evaluates, summarizes and comparatively analyzes the information for the period 2000-2019 on living conditions and environmental factors in urban and rural settlements of the Nenets autonomous okrug (NAO) in relation to the assessment of demographic processes, well-being (quality of life) and health of the NAO population. This review was prepared using the information accessible in the open sources, primarily the official Rosstat data. The analysis clearly demonstrates that the living conditions in the rural NAO areas are characterized by transport isolation, irregular supply of foods and essential goods, outdated housing and social infrastructure, lack of centralized heating, water supply, severage, waste collection and disposal, limited access of the population to medical care, lack of adequate opportunities for education, children's creativity, cultural development, leisure activities, and sports. The living conditions and sanitary-epidemiological situation in the rural NAO settlements (especially in the remote and hard-to-reach villages) should be characterized as unfavourable. The demographic situation in NAO has obvious signs of the formation of a pronounced depopulation trend both among the urban and rural population. The situation among the rural population is alarming: high mortality rates (so far compensated by the high birth rates) accompanied by even higher migration loss, are obviously leading to the further (perhaps irreversible) reduction in the "inhabitability" of the rural NAO areas. Poor demographic situation in the rural NAO areas is accompanied by the increased public health risks (high rates of morbidity).

Aims and tasks

The present review has the aim to evaluate, summarize and comparatively analyze the information for the period 2000-2019 on living conditions and environmental factors in urban and rural settlements of the Nenets autonomous okrug (NAO) in relation to the assessment of demographic processes, well-being (quality of life) and health of the NAO population. This report is reviewing information regarding housing, communal services, social infrastructure, focusing on energy supply, heating, water supply, types of service water to households, use of water pretreatment, availability of sewerage, waste collection and disposal, as well as population access to medical care, the healthcare infrastructure, opportunities for education, children's creativity, cultural development, leisure activities, and sports in NAO. This report is highlighting the present day demographic and public health challenges for living conditions in the rural areas of the isolated Russian Arctic region.

Materials and methods

This review was prepared using the information accessible by fragments in the open sources for the period 2000-2019. To characterize the living conditions of the NAO population (housing, communal services, social infrastructure) the information was collected from the explanatory notes to the NAO territorial planning schemes, "passports" of municipalities, programs for the development of communal infrastructure, and schemes of water supply, water disposal, and waste disposal available at the official website of the NAO administration and the websites of the NAO municipalities, and other technical documentation.

Information on the environmental contamination factors, status of communal and social infrastructure, and sanitary-epidemiological aspects of living conditions in the NAO settlements have been collected from the regional Rospotrebnadzor annual Reports "Status of sanitary-epidemiological wellbeing in NAO", 2011-2020 and the Reports of the NAO "Department of natural resources, ecology and agro-industrial complex", 2010-2020.

Demographic data on the population number, birth rates, general mortality and natural increase rates of the NAO population were collected from the Rosstat "Demographic Yearbooks of Russia", 2002-2020. Information on the net migration rates and the total NAO population change were collected from the Rosstat Bulletins "Number and migration of the population of Russian Federation", 2009-2020.

Data on the causes of death of the NAO population (compared to other Russian Arctic regions) were additionally collected from the Rosstat "Bulletins "Natural movement of the population of the Russian Federation", 2008-2019, and regional "Statistical Yearbooks", 2008-2020.

Data on the morbidity (primary incidence) of the NAO population were collected from the Rosstat Compendiums "Healthcare in Russia", 2001-2021.

Some additional data on the NAO population health were used from the rare scientific publications describing the results of studies carried out in NAO.

The main data sources used for the preparation of the present review are listed in the references without links in the text, since the abundance of the multi-year statistical and technical data (fragmented by individual location, parameter, and calendar year) does not allow citing each element of the information used.

Research Center, St-Petersburg, Russia. Figure 1. Map of Nenets autonomous okrug (NAO). Source: Alexey V. Dozhdikov, Northwest Public Health



Comparative analysis of living conditions and environmental factors in the Nenets Autonomous Okrug

Geography

The NAO is located in northwest Russia beyond the polar circle and ranks 20th among 85 Russian regions in terms of area size; the territory stretches for almost 1000km along the coast of three Arctic seas - White Sea, Barents Sea and Kara Sea (Fig. 1). The NAO relief is mostly flat, dominated by tundra and forest-tundra; marshes and wetlands occupy 19% of the territory. In addition to the main Pechora River, many small rivers and streams flow towards the Arctic seas and the number of lakes exceeds 160,000. Permafrost occupies almost the entire central and northeastern parts of the NAO.

Population

NAO is the least populated region of the Russian Federation with the second lowest population density. Within NAO are: 1 city of Naryan-Mar, 1 township of Iskateley, which is the administrative center of the single Zapolyarny district, comprising 40 rural settlements (Tab. 1).

84% of the population resides in the central part of NAO along the Pechora River, including the urban dwellers (74% of the NAO population). 16% of the population (7,000 people) live in remote villages located in the east (territory of intensive oil and gas production - 6% of the NAO population) and in the west (residence area of the majority of Indigenous people traditionally engaged in reindeer herding - 10% of the NAO population).

Territory, km ²	176,800		
Districts, number	1		
Inhabited localities, number	42		
Population total	44,400		
Population density, people/km ²	0.25		
Urban settlements, number	2		
Under action ante normation	Naryan-Mar city – 25,500		
orban settlements, population	Iskateley township – 7,400		
Rural settlements, number	40		
Urban population (% of the total)	32,900 (74%)		
Rural population (% of the total)	11,500 (26%)		
Indigenous population groups: *			
Nenets, people (% of the total)	7,504 (18.6%)		
Komi, people (% of the total)	3,623 (9.0%)		
Non-Indigenous population: *			
Russians, people (% of the total)	26,648 (66.1%)		
Ukrainians, people (% of the total)	987 (2.4%)		
Belarusians, people (% of the total)	283 (0.7%)		

Table 1. Demographic features of the Nenets autonomous okrug, 2021.

* All-Russian census 2010 data

28% of NAO population is Indigenous (Nenets and Komi). 76% of the Indigenous Nenets reside in rural areas; 47% of them live in the remote and hard-to-reach villages. 73% of the NAO territory is occupied by reindeer pastures, where 29 reindeer breeding brigades operate employing 860

Nenets who lead a nomadic and semi-nomadic lifestyle. Reindeer herding is the main source of livelihood for most Nenets families.

Economy

The basis of the NAO economy is oil and gas production; 50 hydrocarbon deposits are being developed in the eastern NAO; the annual production is 13-14 million tons of oil and about 300 million m³ of natural gas. There is no oil refining industry in NAO; oil is transported through NAO territory by the pipelines network with a total length of more than 1,400 km. The produced gas is not supplied outside the region, it is mainly used by oil companies. Gas supply to NAO population is extremely limited (only the Naryan-Mar city and 3 nearby settlements are supplied). Fuel for the needs of majority of NAO settlements is annually purchased in neighboring Arctic regions (additional costs for the region's budget) and transported by sea in the frames of the "Northern Delivery" (11,000 tons of diesel, 24,000 tons of coal, 9,000 m³ of firewood - on average annually in 2018-2020).

Transport

NAO is the only region of the European part of Russia that does not have railway and highway transport links with neighboring regions. In rural areas there are no paved roads; off-road vehicles are in use in winter season by "winter roads" between some settlements. About 85% of the annual amount of cargo (primarily fuel and basic products) is transported by the "Northern Delivery" in summer up the rivers.

Air transport is extremely dependent on weather conditions. The passenger flights are irregular and expensive. Two airports ("Naryan-Mar" and "Amderma") and 16 unpaved runways in rural settlements are available in NAO. The only local aviation company fleet consists of several light airplanes and a couple dozen of helicopters. There is a high degree of deterioration of aircrafts and ground aviation infrastructure. It should be noted the irregularity in the delivery of foods and vital goods to many settlements, especially to the remote ones; there is a deficit in the supply of some food products (vegetables, fruits, dairy products, etc.) both in summer and winter.

Energy supply

Energy supply of NAO should be considered as a set of systems that provide heat and electricity separately. The developed system of heat supply is functioning only in Naryan-Mar city and Iskateley township, as a network of boiler houses powered by natural gas. The only one in NAO "Naryan-Mar Power Plant" (gas-powered) is supplying with electricity the Naryan-Mar city, Iskateley township and two neighboring villages.

In 12 rural settlements (30%) the heat supply systems are small-scale; it means that small boiler houses and short heat supply networks serve mainly the "socially significant objects" (administrations, kindergartens, schools, medical units, etc); dwellings are heated by their own small boilers or stoves. In 28 villages (70%), there are autonomous boiler houses serving separate municipal buildings; private houses are heated by individual boilers and stoves. Only in two villages (5%) natural gas is in use as fuel for boiler houses, in other 38 NAO villages - either coal (85%) or diesel (10%). Coal and firewood are used for stoves in private houses all over NAO, with the exception of two gasified settlements (Fig. 2).

Figure 2 and all subsequent figures relating to power supply, water supply and sanitation, social infrastructure and consumer services, incl. education and health care (Figures 3-6) reflect the state of affairs in 2010, i.e. in the middle of the 20-year period under study (2000-2019). All the recent changes (they are minor) that occurred between 2010 and 2019 are discussed in the text in each separate section. As for fuel, in the period 2016-2019, the coal was replaced by diesel in 7 villages, while 27 villages (67.5%) continue to use the coal today.

Electricity supply for 87.5% of the rural settlements is provided by local stationary diesel electric power generators. Electricity for the remaining 12.5% of the villages is generated in neighboring settlements and come by the electric power lines. Heat and power generating equipment, electric and heat networks in NAO are characterized by a high degree of wear.



Figure 2. Energy supply in rural NAO settlements in 2010 (number and % of villages).

There is no control of air pollution or monitoring of atmosphere quality in NAO. It's impossible to assess or predict (for different settlements) the exposure levels and potential health risks associated with air emissions of soot (BC particles of various dispersion: PM10, PM2.5, etc) and other products of fuel combustion, emitted into the atmosphere almost all year round.

For the settlements, where the coal is the main fuel for local boilers and stoves, the problem of air pollution is very acute. In these settlements, stacks of coal (and heaps of slag from its combustion) are usually located near the boiler houses, close to dwellings and objects of social infrastructure (schools, kindergartens, medical units, etc). As a result, the inhabitants of these settlements (including children and pregnant women) are directly double exposed to harmful polydisperse carbon fractions - relatively rough coal dust plus fine BC particles. In the residential buildings in such settlements, when the wind blows from the side of the boiler house, it is difficult to breathe;

residents complain on the layer of black dust, constantly accumulating on surfaces in apartments (even with the windows closed).

Water supply and sanitation

Naryan-Mar city and Iskateley township are equipped with the centralized groundwater supply systems. Water from the boreholes for Naryan-Mar enters the storage reservoirs, where the aeration and partial settling of water takes place. The water taken from the storage tanks enters the network to the consumer without chlorination. Water treatment facilities in Iskateley township were built in 2016; in the period 2000-2015 water from boreholes flow to the distribution network without treatment. The unsatisfactory sanitary and technical condition of water supply networks, the lack of scheduled repairs leads to the emergencies and enhances the risk of the secondary contamination of drinking water.

The centralised sewerage system with sewage treatment facilities exists only in Naryan-Mar. Water disposal in Iskateley township was carried out in cesspools and septic tanks; further, liquid municipal wastes (in the period 2000-2017) were transported to the unauthorized dump near the township. Starting from 2018, the housing and communal sewer waters from the Iskateley township began to be transported to the treatment facilities of Naryan-Mar. Wastewaters after treatment at Naryan-Mar does not meet the requirements of hygienic standards for microbiological and physico-chemical parameters. Sewer networks and treatment facilities are worn out, which increases the risk of emergencies.

The abundance of permafrost and swampiness of NAO territory cause significant difficulties in supplying rural population with high-quality drinking water. Amderma township (former military base) is the only one rural settlement where the centralized water supply and sewerage systems function, but the sewage waters through the gravity collectors are discharged into the Kara Sea lagoon without treatment.

As for the rural areas (Fig. 3), the centralized water supply and sewerage systems were absent during the whole period 2000-2019 in 39 villages (97.5%), including 25 villages (62.5%) where the decentralised water supply (without distribution networks) was functioning in 2000-2009. The decentralised sewerage in these 25 villages is organized (up to now) by accumulation of sewage waters in individual or group cesspools, after which they are taken out without cleaning to the unauthorized dumps.

During 2000-2009, there was no water pretreatment in all rural settlements. In some settlements the drinking water was delivered through trucked service. In 2010, 5 villages supplied from the underground sources, and 2 villages supplied from the surface sources, have been equipped with a "block water treatment facility" (Fig. 3).

In 14 villages (35%) during 2000-2009 there was no water supply at all; for the drinking and household needs the people independently delivered water from rivers and lakes, and used melted ice (harvested in late autumn) in winter and spring. In the period 2015-2019, in 7 villages (half of these 14) the decentralized water supply systems (incl. installation of the "block water treatment facility") have been constructed. There is still no water supply in 7 villages (17.5%) today.



* Centralized water supply and sewerage systems in Amderma.

Figure 3. Water supply and sewerage in rural NAO settlements in 2010 (number and % of villages).

In sum it should be concluded that in 2010 the residents of 32 villages (80%) used untreated water; in 2019 the number of such villages dropped to 21 (52.5%). That means that nowadays half of the NAO villages still drink the untreated water, although it is well known that the water from surface water bodies in NAO is characterized by high levels of turbidity and chromaticity, poor selfcleaning ability, low mineralization, high content of iron and organic compounds, severe worsening of quality parameters during spring floods. On the other hand, an unsatisfactory quality of underground NAO waters is caused, as a rule, by poor self-protection of aquifers due to replenishment with surface waters, and by violation of the rules while operating water intake facilities.

The control (and monitoring) of the quality of water sources and drinking water in the rural NAO areas is hampered by a shortage of personnel, laboratory equipment, material support and funding of the regional Rospotrebnadzor. The office of Rospotrebnadzor is located only in Naryan-Mar city; it has no any territorial branches. For inspections of legal entities, the Rospotrebnadzor employees travel each year to some villages; trips to small remote villages are carried out occasionally. As a result, there are shortcomings in coverage of the controlled settlements (especially remote and hard-to-reach), regularity and frequency of data collection, value of the collected materials. All this does not allow an adequate assessment of the state of environment (incl. water quality) in various settlements, taking into account their significant territorial disconnection and remoteness from the center. There is no any data on water quality in the villages, where water supply is not organized, and where the people obtain water on one's own.

Solid wastes disposal

Disposal and utilization of solid wastes (incl. hazardous) is a very serious problem in NAO. There is a single authorized disposal facility for solid wastes in NAO - an open ground area nearby Naryan-Mar city which receives wastes from the city, and also from Iskateley township (since 2017) and Krasnoye village (since 2016). In all rural settlements the solid wastes are placed at unauthorized dumps, which are often located near water intakes and residential areas. In the Amderma township the area of unauthorized dumps (including scrap metal and barrels of fuel and lubricants) is more than 10 hectares with a total volume of 5-7 thousand tons.

Garbage collection at container sites and its further transportation with specialized equipment (garbage trucks) are organized only in 5 settlements (Naryan-Mar, Iskateley, Krasnoye, Kotkino and Nizhnyaya Pesha villages). In 15 rural settlements (36%) the collection and accumulation of solid wastes is organized by local authorities in non-specialized containers. The subsequent removal of wastes to unauthorized dumps is carried out 1-3 times a year (often only "after the snow melts") by trucks, tractors, bulldozers and other non-specialized vehicles. In 22 rural settlements (52%) there is not any arranged procedure for the collection and transportation of wastes; people independently take out wastes by personal transport (snowmobiles, dog sledges) "to swamps or tundra".

It should be noted that the environmental pollution in the rural settlements (particularly in the remote and hard-to-reach) is caused by the presence of unauthorized dumps, chaotic placement of fuel storage sites, the proximity of housing and social facilities with boiler houses, garages, repair shops and other technical facilities.

Social infrastructure and consumer services

Social infrastructure and consumer services in rural NAO settlements presented in Figure 4.



Figure 4. Social infrastructure and consumer services in rural NAO settlements in 2010 (number and % of villages).

Comparative analysis of living conditions and environmental factors in the Nenets Autonomous Okrug

Education

In urban NAO settlements the secondary general education (11 classes) is available today in 6 schools in Naryan-Mar and one school in Iskateley township; the preschool education is available in 9 public and 6 private kindergartens in Naryan-Mar and in 3 public kindergartens in Iskateley township.

Rural settlements face shortage of schools and kindergartens. In 2010, 12 villages (30%) had no schools; 28 villages (70%) had one school (Fig. 4). Available levels of school education in rural settlements in 2010 presented in Figure 5.

In 2010, 26 villages (65%) had a kindergarten, while 14 villages (35%) did not have (Fig. 4). The situation with schools and kindergartens in rural NAO settlements got worse in 2014-2017 when in 3 small villages where the preschool/elementary school units (school and kindergarten are combined in one building) were closed. As a result the number of rural settlements deprived of the educational entities has increased to 15 villages (no schools – 37.5%) and 17 villages (no kindergartens – 42.5%).



Figure 5. Structure of school education in NAO rural settlements, 2010 (number and % of villages).

In 2017, 70% of schools in NAO did not meet modern requirements for equipment and facilities. In rural areas 46% of schools did not have indoor sport facilities; 25% of schools were not equipped with centralized water supply and sewerage; many school buildings needed major repair. As part of the state program in NAO, measures are currently being taken to build new schools and carry out renovation of school buildings.

Secondary vocational (professional-technical) education is available only in Naryan-Mar. Higher education is currently unavailable in NAO; higher institutions from neighboring Arkhangelsk oblast, which previously had branches in Naryan-Mar, were closed in 2007.

Culture

There are several cultural institutions in Naryan-Mar, including a palace of culture, central library, ethno-cultural centre and two museums. There are no theatres, concert halls, or circuses in the NAO capital.

In the Iskateley township and in each of 36 rural settlements (90%) during the whole period 2000-2019 the single so called "House of culture" was available. Usually it is a relatively small building with 2-3 rooms, with a library, and a space for children's and adult's creativity (amateur folk art, singing, dancing, etc). Obviously, such houses provide very limited opportunities for leisure activities and cultural entertainment for the residents of a settlement. Four villages (10%) have no "Houses of culture" (Fig. 4).

Sports

There are 54 sports facilities in Naryan-Mar, including 30 sport halls, swimming pool, indoor ice rink, shooting range, ski base. Sport hall, ski-roller track, two hockey courts and 2 gyms are available in Iskateley township.

In 26 villages (65%) the sports indoor facilities were absent in 2000-2017 (Fig. 4), apart from some unequipped (uncovered) outdoor sports grounds. 8 villages (20%) dispose only a sport room in a local school in 2000-2019. In 6 rural settlements (15%) the "sport-recreation complexes" were built in 2010-2015; in 2 villages the indoor sports facilities were built in 2019.

Consumer services

In Naryan-Mar city and Iskateley township, there are enough organizations providing consumer services to the population, such as public baths, canteens, restaurants, bars, various shops, etc.

During 2000-2019, 15 villages (37.5%) are deprived of bathhouses; 24 rural settlements (60%) have no canteens. Only 13 villages (32.5%) have more than one shop, where people can buy all foods and goods (Fig. 4).

Healthcare

Specialized medical care in NAO can be obtained in the state medical institutions in Naryan-Mar (Nenets okrug hospital, Nenets okrug dental clinic, Nenets okrug tuberculosis dispensary) and in Iskateley township (Central Zapolyarny district polyclinic), and also in few private medical organizations in Naryan-Mar. High-tech medical care is unavailable in NAO, due to the lack of appropriate opportunities.

The Nenets okrug hospital disposes 243 beds in 13 specialized medical departments; there are also 37 beds in the "day hospital" and 20 beds in the outpatient clinic.

The key problem of the NAO healthcare system is the limited access of rural population to medical aid and treatment. The lack of reliable transport routes, low level of logistic links and low accessibility of medical institutions for residents of remote settlements, the shortage of doctors, especially "narrow" specialists, and deficiency of the adequate laboratory facilities worsen the

quality of medical care for the population. As of 2019, 60% of the rural healthcare buildings were constructed in the middle/second half of the 20th century and require major repairs and modernization.

In 25 rural settlements (62.5%) only primary medical care in the first-aid posts (one medical assistant on staff) is available. There was an outpatient clinic in 10 villages (25%) in 2000-2015, which, as a rule, employ one general practitioner and 2-7 mid-level medical workers (Figure 6). The outpatient clinic has no inpatient sector (no beds); after receiving primary medical care the patients are treated at home, and if necessary, are referred for consultation or inpatient treatment to the Nenets okrug hospital in Naryan-Mar.

In 2016, the outpatient clinics in four villages were abolished to first-aid posts, which made medical care even less accessible and qualified for the rural population. Today 29 villages (72.5%) dispose only first-aid posts.



Figure 6. Health care institutions in NAO rural settlements in 2010 (number and % of villages).

Hospitals disposing inpatient departments (10-25 beds) are available in five rural settlements (12.5%). Unlike outpatient clinics, hospitals employ more doctors (2-4) and mid-level medical staff (up to 17).

Ambulance (including medical evacuation) for the residents of remote villages is provided by air ambulance. On average annually, 230 air ambulance flights are carried out in NAO; more than 400 NAO residents are evacuated to Naryan-Mar; about 60 patients are evacuated outside the NAO. Short daylight in the autumn-winter period, lack of airfields in a number of villages, and strong dependence on weather conditions hinder the flights.

Due to the nomadic lifestyle, the reindeer herders have no regular access to health care units. Nevertheless the NAO reindeer herders are not completely deprived of medical care. The medicalsocial project "Red Chum" was reestablished in NAO on the initiative of the Association of the Nenets People "Yasavey" with the financial support of the oil-and-gas company LUKOIL in 2002. In 2008, the project received a long-term annual planned character and new financial partners. The main objectives of the project are: access to medical care for the nomadic population in hard-toreach areas, examination and treatment of reindeer herders and their families, medical prevention, first aid training, providing the pharmaceuticals. The mobile medical teams of the "Red Chum", usually consisting of several medical specialists, are annually visiting some reindeer herding brigades in the remote NAO areas.



Analysis of the demographic data

Figure 7. Number of NAO population (urban, rural and total) in 2000-2019.

The total NAO population number in the period 2000-2019 slightly increased by 6.5%, which was determined by the increase of the urban population by 24.9%, while the rural population has decreased by 24.2% (Figure 7).

The demographic rates presented in the figures below cover the period 2011-2019, as no data on the urban and rural NAO population (separately) are available for earlier years in the Rosstat materials.

An increase in the total NAO population number in the period 2011-2019 (by 4.1%) was due to a high birth rate (16.0 per 1000 on average), more than 1.5 times higher than the general mortality rate (9.4 per 1000), slight natural increase (6.6 per 1000), relatively low migration rates (-1.5 per 1000) with a positive overall population growth (5.1 per 1000). There is an impression of a relatively favorable demographic situation in the region; however, the real state of affairs should be evaluated separately for the urban and the rural NAO population in dynamics in recent years (Figure 8).



Figure 8. Rates of births, general mortality, natural increase (RNI), net migration and total population change of urban, rural and total NAO population in 2011-2019 (per 1000).

While in the period 2011-2019 the birth rate of the urban NAO population is 20.3% lower than that of the rural population, both groups have about quarter decrease in 2016-2019. At the same time the general mortality rate of the rural residents (14.3 per 1000) is almost twice as high as the death rate of the urban ones (7.4 per 1000). The positive natural increase rate in NAO is provided (in 2011-2016) mainly by the urban population, but the intensive drop in 2017-2019 is determined by the urban and particularly the rural population (up to 1.3 per 1000).

The positive migration increase rate of the urban population in 2011-2015 is replaced by a decline in 2016-2018, while in the countryside the migration loss is relatively constant throughout the entire period of 2011-2019 (averaging -21.6 per 1000). As a result, some total population growth in NAO (5.1 per 1000) is accompanied by a high overall decline in the rural population (-17.2 per 1000) with a significant overall urban population growth (14.3 per 1000). However, the urban population growth is determined by its exceptionally high rates (up to 24.5 per 1000) in the period 2011-2015, which was followed by the sharp downward trend in the period 2016-2018 (Figure 8).

Thus, it should be stated that the demographic situation in NAO got worse significantly in recent years; there are obvious signs of the formation of a pronounced depopulation trend both among the urban and rural population. The overall growth of the urban population has dropped by an order of magnitude over the period 2011-2018, primarily due to the progressive increase in migration loss. The situation among the rural population should be characterized as critical: high mortality rates (so far compensated by the high birth rates) accompanied by even higher migration loss, are obviously leading to the further (perhaps irreversible) reduction in the "inhabitability" of the rural NAO areas.

Additionally, it is important to note that, according to the official Rosstat estimates, the life expectancy at birth in 2019 for the rural NAO population is 67.4 years, which is 8.3 years less than the corresponding value for the urban population (75.7 years).

Analysis of the mortality data (causes of death)

NAO has the second highest (24.1 per 10,000) mortality rates from external causes of death (averaged for the period 2000-2019) among all Russian Arctic regions, after Chukotka autonomous okrug (28.0 per 10,000); Komi republic is the "third ranked" (22.2 per 10,000).

Figures 9 and 10 show the dynamics of crude mortality rates from the main causes of death (external and circulatory) for the urban and rural NAO population; the standardized mortality rates are unavailable in the Rosstat materials.



Figure 9. Mortality from External causes of death, crude rates for urban and rural NAO population in 2000-2019 (per 10,000).

Figure 9 demonstrates that the average (for 20 years) mortality rate from external causes among the rural NAO population is 2.3 times higher compared to the urban population. However both population groups have a decreasing mortality trend during 2000-2019 (by 73.4% for the urban and by 38% for the rural NAO population).

Suicides make significant contribution to the mortality from external causes. NAO has the second highest (59.5 per 100,000) mortality rates from suicides (averaged for the period 2006-2019) among all Russian Arctic regions, after Chukotka autonomous okrug (61.3 per 100,000); Yakutia republic is the "third ranked" (37.2 per 100,000). Data on the NAO suicide mortality for 2000-2005 are unavailable in the Rosstat materials.

The study of fatal suicides in NAO in 2002-2012 has demonstrated 1.5 times higher standardized suicide mortality rates in the Indigenous Nenets population (72.7 per 100,000) which reside mainly in rural areas, compared with the non-Indigenous population (50.7 per 100,000) which are mainly urban dwellers (Sumarokov et al., 2014).

It has long been established that alcohol is a major risk factor for external causes of death, incl. suicides, particularly among the Indigenous people of the Arctic. In the frames of the same study of fatal suicides in NAO in 2002-2012, it was shown that alcohol was present in the blood (postmortem analysis) of 78.3% of male and 92.3% of female suicide cases among the Indigenous NAO population. Data from the neighboring Arkhangelsk oblast (non-Indigenous people) showed significantly lower proportions of blood alcohol content in the fatal suicide cases (59.3% in males and 46.6% in females) (Sumarokov et al., 2016).



Figure 10. Mortality from diseases of Circulatory system, crude rates for urban and rural NAO population in 2000-2019 (per 10,000).

A similar (to the external causes) situation is observed for the circulatory mortality (Fig. 10). The average circulatory mortality rate among the rural NAO population is 1.5 times higher than the level among the urban population, and both curves are descending (by 52.1% among the urban and by 24.8% among the rural population) in the period of 20 years.

Table 2 demonstrates that the rates of mortality from neoplasms, diseases of digestive system, respiratory system, infectious-parasitic diseases among the NAO rural population are higher than the corresponding rates among the urban population, particularly for the infectious and parasitic diseases.

Causes of death	Urban population death rate (per 10,000)	Rural population death rate (per 10,000)	Excess of the rural death rates over the urban (%)
Neoplasms	13.7	17.3	27%
Digestive system diseases	4.3	4.6	7%
Respiratory system diseases	2.7	3.0	9%
Infectious and parasitic diseases	0.73	1.17	60%

Table 2. Crude mortality rates for some causes of death among rural and urban NAO population,averaged for 2000-2019

Additionally, it is worth mentioning that the infant mortality among the rural NAO population (19.3 per 1,000 live births) was on average 1.6 times higher than in the urban population (11.9 per

1,000 live births) in the period 2000-2011, but during 2012-2019 the infant mortality levels in both population groups significantly decreased and became similar (4.0 per 1,000 live births).

Analysis of the morbidity data (primary incidence)

Data on the morbidity (primary incidence) are available only for the total NAO population; data on the morbidity of the NAO rural and urban population are unavailable wherever in the official statistics.

NAO is characterized by the highest (1567.2 per 1000) general morbidity rates (averaged for the period 2000-2019) among all the Russian Arctic regions, followed by Yamalo-Nenets autonomous okrug (1169.9 per 1000) and Chukotka autonomous okrug (1165.8 per 1000).

NAO is also the "leader" of infectious-parasitic primary incidence (65.5 per 1000) in the Russian Arctic; the second and the third "places" are occupied by Komi Republic (51.9 per 1000) and Yamalo-Nenets autonomous okrug (49.1 per 1000).

Our study 10 years ago (Dudarev et al., 2013) based on the official data from the Federal database "Social-Hygienic Monitoring" has demonstrated that in the period 2001–2011, among all regions of the Russian Arctic, Siberia and the Far East, the NAO average primary incidence levels of certain food-and-waterborne diseases were rather high, incl. bacterial infections (salmonellosis 43.7 per 100,000; shigellosis sonnei 20.6; yersiniosis 3.72), protozooses (giardiasis 323.8 per 100,000), helminthiases (enterobiasis 1079 per 100,000; beef tapeworm 1.089; pork tapeworm 1.5; diphyllobothriasis 213.9) and zoonoses (tularaemia 0.8 per 100,000). The NAO incidence rates of the giardiasis and enterobiasis were the highest among all the studied regions.

High levels of parasitoses (giardiasis, enterobiasis, diphyllobothriasis, etc) were described in NAO during the target parasitological studies of 2002-2013 when the additional serological diagnostic methods have been applied both in the rural and urban NAO settlements, among Indigenous and non-Indigenous population. The authors attribute the high levels of parasitoses among the rural NAO population to the unsatisfactory sanitary and hygienic living conditions, household overcrowding, lack of centralized water supply and sanitation, lack of sewage treatment in most rural settlements; the entry of pathogens into open water sources causes the contamination of drinking water. The authors point to the ineffectiveness of measures aimed at the prevention of parasitoses in NAO, especially in relation to children; in practice, measures are reduced only to the treatment of identified infested persons (Bobyreva et al., 2016).

Conclusions

NAO is an isolated Arctic region which does not have railway and highway transport links with neighboring regions; there are no paved roads in the rural areas. Air transport is irregular and expensive; delivery of foods and vital goods to the remote settlements is sporadic.

Despite the fact that the basis of the NAO economy is oil and gas production, the gas supply to the NAO settlements is extremely limited; the fuel (coal, diesel, firewood) for the majority of the NAO settlements is annually purchased in the neighboring Arctic regions and transported by sea in the frames of "Northern Delivery".

The centralised systems of heat and electricity supply, water supply and disposal, sewage and solid wastes disposal are functioning only in two urban settlements. Coal or diesel is used as fuel in

autonomous boiler houses serving separate municipal buildings in most of rural settlements. Coal and firewood are used for stoves in private houses all over the region. Electricity supply in villages is provided by local stationary diesel electric power generators. There is no control of air pollution or monitoring of atmosphere quality in NAO.

Nowadays all rural settlements (except one former military base) are deprived of the centralized water supply and sewerage systems; in most villages the decentralised systems are organized without distribution networks. Some settlements are supplied by drinking water through trucked service. As a rule, the rural settlements use drinking water without pretreatment. Accumulation of sewage waters in cesspools, with subsequent delivery (without cleaning) to the unauthorized dumps is applied in most villages. There is still no water supply and sewerage in seven villages now; people independently deliver water from rivers and lakes, somewhere using melted ice harvested in late autumn. The control (and monitoring) of the drinking water quality in the rural areas is inadequate; in the villages, where the people obtain water on one's own, the water quality is out of control.

In all rural settlements the solid wastes are placed at unauthorized dumps, which are often located near water intakes and residential areas. In a half of rural settlements the collection or transportation of wastes is not organized; people take out the wastes by personal transport (snowmobiles, dog sledges) to "swamps or tundra".

The availability of the entities of social infrastructure and consumer services in the rural settlements is extremely insufficient; in many villages there are no schools, kindergartens, "houses of culture", indoor sport facilities, bathhouses, canteens. Majority of villages have only one shop, where people can buy foods and goods.

The key problem of the NAO healthcare system is the limited access of rural population (particularly of the remote settlements) to medical aid and treatment. The shortage of doctors, especially "narrow" specialists, deficiency of equipment and laboratory facilities worsen the quality of medical care. In most rural settlements only primary medical care is available in the first-aid posts (one medical assistant on staff).

The demographic situation in NAO got worse significantly in recent years; there are obvious signs of the formation of a pronounced depopulation trend both among the urban and rural population. The overall growth of the urban population has dropped by an order of magnitude over the period 2011-2018, primarily due to the progressive increase in migration loss. The situation among the rural population should be characterized as critical: high mortality rates (so far compensated by the high birth rates) accompanied by even higher migration loss, are obviously leading to the further (perhaps irreversible) reduction in the "inhabitability" of the rural NAO areas.

NAO has the second highest mortality rate from external causes of death (incl. the suicide rate) among all Russian Arctic regions; the rural NAO population has 2.3 times higher rate compared to the urban.

NAO has the highest general morbidity and the infectious-parasitic primary incidence among all the Russian Arctic regions. Some authors attribute the high levels of parasitosis among the rural NAO population to the unsatisfactory sanitary and hygienic living conditions, household overcrowding, lack of centralized water supply and sanitation, lack of sewage treatment in most rural settlements. Thus the living conditions and sanitary-epidemiological situation in the rural NAO settlements (especially in the remote and hard-to-reach villages) should be characterized as unfavourable. This is confirmed by high migration loss, high rates of mortality and the increased public health risks (high rates of morbidity).

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References

- Bobyreva, N. S., Korneeva, Y. A., & Degteva, G. N. (2016). Analysis of parasitological situation in Nenets autonomous district. *Gigiena i Sanitaria (Hygiene and Sanitation)*, 95 (2), 157-162, DOI: 10.18821/0016-9900-2016-95-2-157-162
- Bulletin "Natural Movement of the Population of the Russian Federation" (2008-2019). Rosstat. Retrieved from https://rosstat.gov.ru/compendium/document/13269
- Bulletin "Number and migration of the population of Russian Federation" (2009-2020). Rosstat. Retrieved from https://rosstat.gov.ru/compendium/document/13283
- Compendium "Healthcare of Russia" (2001-2021). Rosstat. Retrieved from https://rosstat.gov.ru/folder/210/document/13218
- Demographic Yearbook of Russia (2002-2020). Rosstat. Retrieved from https://rosstat.gov.ru/folder/210/document/13207
- Dudarev, A. A., Dorofeyev, V. M., Dushkina, E. V., Alloyarov, P. R., Chupakhin, V. S., Sladkova, Y. N., Kolesnikova, T. A., Fridman, K. B., Nilsson, L. M., & Evengard, B. (2013). Food and water security issues in Russia III: food- and waterborne diseases in the Russian Arctic, Siberia and the Far East, 2000-2011. *International journal of circumpolar health*, 72, 21856. https://doi.org/10.3402/ijch.v72i0.21856
- Report "On the results of the activities of the head of the Administration of the Zapolyarny region" (2019). Administration of the Zapolyarny region. Retrieved from https://www.zrnao.ru/?id=6419
- Report "On the state of reindeer breeding in the Nenets Autonomous Okrug" (2019). Department of natural resources, ecology and agro-industrial complex. Retrieved from https://dprea.adm-nao.ru/informaciya-dlya-olenevodov/
- Reports "On the state and protection of the environment in NAO" (2010-2020). Department of natural resources, ecology and agro-industrial complex. Retrieved from https://dprea.adm-nao.ru/

- Reports "Status of sanitary-epidemiological wellbeing in NAO" (2011-2020). Rospotrebnadzor. Retrieved from http://83.rospotrebnadzor.ru/
- Statistical Yearbooks of the NAO (2010-2020). Rosstat. Retrieved from https://arhangelskstat.gks.ru/publication_arh
- Sumarokov, Y. A., Brenn, T., Kudryavtsev, A. V., & Nilssen, O. (2014). Suicides in the Indigenous and non-Indigenous populations in the Nenets autonomous okrug, northwestern Russia, and associated socio-demographic characteristics. *International journal of circumpolar health*, 73, 24308. https://doi.org/10.3402/ijch.v73.24308
- Sumarokov, Y. A., Brenn, T., Kudryavtsev, A. V., Sidorenkov, O., & Nilssen, O. (2016). Alcohol and suicide in the Nenets autonomous okrug and Arkhangelsk oblast, Russia. *International journal of circumpolar health*, 75, 30965. https://doi.org/10.3402/ijch.v75.30965
- Territorial planning documents. Department of construction, housing and communal services, energy and transport of NAO. (2009-2017). Retrieved from https://gkh.adm-nao.ru/arhitektura-i-gradostroitelstvo/dokumenty-territorialnogo-planirovaniya/