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_____ V.P. Chashchin

October 28, 2010

RESEARCH REPORT

"DEVELOPMENT OF RECOMMENDATIONS ON IMPROVEMENT OF HEALTH PROTECTION SYSTEM FOR A NATIVE POPULATION INTENSIVELY EXPOSED TO ENVIRONMENTAL CONTAMINANTS IN THE ARCTIC PART OF THE RUSSIAN FEDERATION"

Pilot project

(CONSULTING CONTRACT No. CS-NPA-Arctic-16/2010)

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Acknowledgements

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Summary

Report parameters: The total size of report is pages. It contains 15 figures, 16 tables, a list of references and 2 appendices.

List of key words: native population of the Arctic, health risk factors, prevention strategy and methods of health effects associated with the POP exposures in the Arctic part of the Russian Federation (APRF).

Aims: Evaluation of health impact of the implementation of the local remediation plan based on the 2003 AMAP recommendations (appendix 1) in the period from 2005-2010 involving examined in 2001 indigenous cohorts, residents of selected native communities of Chukotka AO heavily polluted by persistent toxic substances (PTS).

Results

The report presented an analysis of the indicators characterizing main biomarkers of exposure to PTS and health indicators of representative groups (30 men and 30 women) from among smaller peoples historically living in a coastal zone of the Russian part of Arctic regions (Chukchi autonomous okrug, Municipal formation “Chukchi rayon”). On the basis of modern scientific methods of evaluation and control of integrated indicators of population health, materials proving priority directions of strategic planning of a health promotion program in

hard-to-reach, ecologically problem areas of the Russian part of Arctic regions are presented for the first time. As a methodological basis for evaluation of changes of risk factors of health loss among native population of AZRF for the first time in the Russian practice the method of cohort researches, based on comparison of indicators characterizing the content of persistent chlorine organic pollutants both in habitat (inside dwellings), and their content in an organism of separate inhabitants which have been examined for the first time by the report of AMAP in 2001, is used. Besides, an analysis of morbidity rate of the inhabitants living in settlements of Chukchi rayon taking into account the volume of implemented recommendations of AMAP (2003) for decrease of health risks for the population is carried out within the limits of the pilot project.

For a correct social and economic evaluation of efficiency of performed health improving and rehabilitation programs in these settlements and degree of stability of their demographic development, the method of definition of indicators of expected average loss of life years by separate nosological forms corrected for disability (WHO 2002) modified by us is applied.

Results of the pilot project testify, in particular, that neither PTS pollution indexes for dwellings of the investigated cohort of inhabitants, nor content of these compounds in blood of repeatedly (in 9 years) examined persons, nor their morbidity and mortality rates due to the causes potentially connected with intensity of influence of persistent chlorine organic pollutants, allow to consider the measures for risk decrease taken at local level, sufficient.

Moreover, it has been shown that there is a possibility of further increase in harmful influence of some highly toxic contaminations, first of all those the sources of which mainly are local, including waste containing polychlorinated biphenyls (PCB) and lead (tetraethyl lead). Factors promoting accelerated release of these substances into the environment from unorganized dumps and burial grounds for barrel ware, polluted with spent lubricant and transformer oils, tetraethyl lead, etc., should include thermal degradation of permafrost soil in connection with observable and expected climate changes, and also non-professional (uncontrollable) actions of local population in collecting and transportation of polluted barrel ware and other dangerous waste in the territory of

inhabited settlements to so-called “places of safe storage”. It is obvious that as a whole the useful initiative of Association of the native smaller peoples of the North (AKMNS) on sanitary purification of settlements of dangerous waste (2007-2009) requires professional planning and provision with necessary means preventing "secondary" pollution with PTS during these operations.

Recommendations for improvement of planning of the actions directed to decrease of harmful influence of polluting substances on a human, and also recommendations for introduction of more advanced methods of hygienic training of the local population, considering features of social, economic and ecological conditions, and also cultural traditions of the population have been developed. Introduction of these recommendations, undoubtedly, will promote solving of one of the main problems within the framework of “Foundations of Public Policy in Arctic Regions” approved on 28.05.by the President of the Russian Federation.

Main practical purpose and scope of planned results.

Improvement of planning of health promotion program and rehabilitation actions in settlements of the native people of AZRF exposed to superfluous risk of harmful influence of persistent toxic substances, polluting the environment of their dwelling.

List of abbreviations

AC – Arctic Council

AMAP - Arctic Monitoring Assessment Program
ACAP - Arctic Council Action Program

ILO - International Labor Organization

SDWG - Sustainable Development Working Group

WHO – World Health Organization –

HXB - hexachlorobenzene

HCB - Heptachlorbenzene

LNP – Local native peoples

SR – scientific research

MAC - maximum allowable concentration

MAE – maximum allowable emission

PCB - polychlorinated biphenyls

RF – Russian Federation

POPs – Persistent Organic Contaminants

PTC – persistent toxic substances

SOCs – stable organic compounds

ChAO – Chukchi autonomous okrug

FGUN - Federal State Research Institute

Terms and definitions

Sanitary-and-epidemiologic wellbeing – parameters characterizing a habitat condition when there is no harmful influence of factors on a human, and favorable conditions of his life activity are provided [FZ No. 52].

Human environment (habitat) – set of objects, phenomena and factors of the environment (natural and artificial), defining conditions of human's life activity [FZ No. 52].

Safety - absence of inadmissible risk.

Risk - combination of damage probability and severity of this damage.

Damage - physical damage or harm to people's health, or damage to property or to the environment.

Event causing damage - event when a dangerous situation leads to damage.

Danger - a potential source of damage.

Dangerous situation - circumstances in which people, property or the environment are exposed to danger.

Permissible risk - risk that is considered admissible in the given context with existing public values.

Protective measure - a measure used for risk reduction.

Risk analysis - regular use of the available information for revealing of dangers and quantitative estimation of a risk.

Risk assessment - verification procedure based on the results of the risk analysis revealing whether the admissible risk is exceeded.

Health – a condition of full physical, mental and social well-being, and not just absence of illness or physical defects (the Preamble of the WHO's Charter). Health – dynamic process, depending heavily on individual ability to adapt to the environment; to be healthy means to keep intellectual and social activity, despite damages or lacks (WHO ERB, 1978).

Health damage –physical, mental or social problems connected with loss, anomaly, disorder of psychological, physiological, anatomic structure and (or) function of a human body (Ministry of Health of Russia and Ministry of Labor of Russia, 1997).

Social-hygienic monitoring–state system of supervision over health condition of the population and a habitat, their analysis, estimation and forecast, and also definition of relationships of cause-and-effect relations between health condition of the population and influence of habitat factors (52-FZ, 1999).

Monitoring in medicine – long regular collection, analysis, interpretation and distribution of the data for preventive purpose. Monitoring is important for planning, introduction and estimation of programs of medicine of labor and for the control of health damage and traumas, and also for protection and promotion of employee s' health. Monitoring in labor medicine includes monitoring of employees' health and working environment monitoring (MOT, 1998).

Pregnancy planning - definition of optimum conception time taking into account medical recommendations**.** It is provided with creation of environment excluding influence of harmful and dangerous industrial and other factors on a woman's organism at the period of conception and early terms of pregnancy development.

Reproductive health - condition of full physical, mental and social well-being in all areas, concerning reproductive system, its functions and processes, including reproduction of posterity and harmony in psycho-sexual relations in a family (the United Nations, Cairo, 1994).

Group (population) risk – probability of that a group of workers will simultaneously experience adverse consequences of the given working conditions for a year or a working experience; usually exactly this risk is considered.

Individual risk– probability of someone from a group to suffer from influence of the given working conditions for a year or the working experience. Individual risk is estimated taking into account risk factors of the given employee. Work experience over half an average term of industrial disease development in the given profession is considered a strong risk factor.

Note. There is no definite answer to a question which of these two risks or both of them should be considered during serious decisions about a risk. For example, is a big risk for small number of people more important than small risk for a great number of people? At the limited resources a question is important - which part of workers it is impossible to protect in the given way (WHO, 2001). Estimations of group risk can serve as a measure of individual risk adjusted for a sex, age, health condition, individual perceptiveness, etc. High risk groups (vulnerable groups) are singled out: pregnant women, nursing mothers, teenagers, disabled people, migrants, etc.

Exposition - quantitative characteristic of intensity and duration influence of harmful factor (P 2.2.2006-05).

Ecological risk — possibility of negative changes in the environment, or remote adverse consequences of these changes arising owing to negative influence on the environment.

Disease –index of a number of patients revealed within a year with certain diseases, calculated for 100, 1000, 10000, 100000 of population exposed to the influence of harmful factors of the production environment and labor process.

Ecologically caused disease - morbidity (standardized by age) with general diseases of various etiology (mainly polyetiologic), tending to increase in the process of stay in adverse environmental conditions and exceeding expected rates in control groups of population not subject to risk of harmful influence on an organism.

Environment - set of environmental components, natural and natural-anthropogenic and anthropogenic objects.

Natural environment - set of environmental components, natural and natural-anthropogenic objects.

Environmental components - earth, subsoil, soils, superficial and underground waters, atmosphere air, plant and animal life and other organisms, and also an ozone layer of the atmosphere and near-Earth space environment, providing in the aggregate favorable conditions for existence of life on the Earth.

Natural object - natural ecological system, natural landscape and the elements constituting them remain their natural properties.

Natural-anthropogenic object - natural object changed as a result of economic and other activity, and (or) an object created by a human, possessing properties of a natural object and having recreational and protective value.

Anthropogenic object - object created by a human for provision of his social needs and not possessing properties of natural objects.

Natural ecological system - objectively existing part of the environment having spatial-territorial borders and in which live (plants, animals and other organisms) and its inanimate elements co-operate as a uniform functional whole and are related to each other by metabolism and energy interchange.

Environmental protection- activity of public authorities of the Russian Federation, public authorities of parties of the Russian Federation, local bodies, public and other non-commercial entities, legal bodies and individuals, directed to

preserving and restoration of the environment, rational use and reproduction of natural resources, prevention of negative influence of economic and other activity on environment and elimination of its consequences (further also - nature protection activity).

Quality of the environment - condition of the environment characterized by physical, chemical, biological and other parameters and (or) their set.

Favorable environment - environment, quality of which provides steady functioning of natural ecological systems, natural and natural-anthropogenic objects.

Natural resources - environment components, natural objects and natural-anthropogenic objects used or can be used during implementation of economic and other activity as sources of energy, ware and consumer goods and have consumer value.

Environmental contamination - entry of a substance and (or) energy to the environment, property, location or quantity of which have negative influence on the environment.

Pollutant - a substance or a mix of substances, quantity and (or) concentration of which exceed standards established for chemical substances, including radioactive, other substances and microorganisms and have negative influence upon the environment.

Quality standards of the environment - standards established according to physical, chemical, biological and other parameters for evaluation of environmental condition and due to observance of which favorable environment is provided.

Standards of permissible discharges and dumps of chemical substances, including radioactive, other substances and microorganisms - standards established for bodies of economic and other activity according to indicators of

weight of chemical substances, including radioactive, other substances and microorganisms, admissible for the environment from stationary, portable and other sources in the established mode and taking into account technological standards and at observance of which quality standards of the environment are provided.

Standards of maximum permissible concentration of chemical substances, including radioactive, other substances and microorganisms - standards established according to indicators of the maximum permissible content of chemical substances, including radioactive, other substances and microorganisms in the environment and non-observance of which can lead to environmental contamination, degradation of natural ecological systems.

Standards of admissible physical exposures - standards established according to levels of admissible influence of physical factors on the environment and at observance of which quality standards of the environment are provided.

Evaluation of influence upon the environment - a type of activity on revealing, analysis and accounting of direct, indirect and other consequences of influence on the environment of scheduled economic and other activity with a view of decision-making on possibility or impossibility of its implementation.

Monitoring of the environment (ecological monitoring) – a complex system of control of the, evaluation and forecast of changes of environmental condition under the influence of natural and anthropogenic factors.

Harm to environment - negative change of environment resulted from its pollution, caused degradation of natural ecological systems and depletion of natural resources.

Ecological risk - probability of the event having adverse consequences for environment and caused by negative influence of economic and other activity, emergency situations of natural and anthropogenic nature.

Ecological safety - a condition of security of the environment and vital interests of a human from possible negative impact of economic and other activity, emergency situations of natural and anthropogenic nature, their consequences.

Introduction

1.1. Priorities in the sphere of health protection of the native population of AZRF

Good health in consciousness of the majority of people is an indispensable condition of well-being, as well as a precondition for ability to work and care of future generations. Many inhabitants of Arctic regions have to face challenges in security of a good health level.

As it was declared in one of the first reports to the Arctic Council (Helsinki, 2002), devoted to health protection of people living in Arctic regions, special economic living conditions, impact of severe environmental conditions and harmful anthropogenic pollutions specifically collecting in the Arctic ecosystems, swift changes of traditional meals character, and also geographical and political isolation set many challenges.

Native smaller peoples with their continuous relationship with land, traditional forms of nutrition and frequently marginal status are subject to impact of harmful factors often in a greater degree, than other population. Arctic cooperation expands knowledge of health risks, connected with use of traditional foodstuff substantially containing stable toxic pollution, about ways of prevention infectious diseases and about systems of long-distance medical care.

In some Arctic regions people who continue using traditional food, are characterized by high concentration of ecological contaminants circulating in blood and getting in extremely high concentration to children's organisms, raised with breast milk. As a result of thinning of the ozonosphere of the Earth, ultra-violet radiation influences in escalating degree both the Arctic ecosystem and the population.

However national programs give the central value to stable high-toxic contaminations arriving to AZRF by global transport from remote areas of the Earth at the expense of specific circulation of ocean, river and atmospheric streams (fig. 1, 2, 3).

Fig. 1. Area of the most intensive global transport of pollution.

Fig. 2. Global ocean streams – sources of PTS transport to Arctic regions.

Fig. 3. Peculiarities of a drain of large rivers running into the Arctic seas.

It is found that 70 % of water volumes arriving to Arctic regions are formed of a drain of large rivers basin of which is located several thousand kilometers to the south of a polar circle.

However, for more than 80-year-old period of intensive economic development of Arctic regions, many territories have huge quantities of a dangerous waste, including containing PTS which, as it is known, pose special threat to vulnerable environment and health of the population of this extensive Russian region, especially at the period of essential climate changes. According to the statement of the prime minister of the Russian Federation V.V.Putin at the Arctic forum on April 23, 2010, Russia has some main priorities of public policy in Arctic regions – "The first: creation of qualitative comfortable conditions for life of people, preservation of originality of native peoples. Any industrial project will not be realized without taking into account ecological requirements - this is a position of principle of the government, - V.V.Putin has specified. - Value of Arctic regions is higher than those barrels of oil and gas volumes which we can

receive there. The third priority: “general cleaning of Arctic regions”. Literally - to clear away dumps around human settlements, stations, military bases. ».

1.2. Project Objective

Main objective of this pilot project is to obtain the estimation of change of harmful impact intensity of resistant pollution on organisms of the inhabitants of Chukchi AO and development of recommendations on application of methods of estimation and planning of health promotion program and rehabilitation actions adapted to the conditions of polluted Arctic settlements.

1.3. Main tasks

Main tasks of the pilot project included repeated examination of health level of a cohort of native people including 30 women and 30 men, living in settlements of Chukchi AO who took part in similar medical ecological examination in 2001. It was thus supposed:

1. To characterize and perform a comparative analysis of time tendencies in formation of impact of compounds of lead, mercury, cadmium and stable chlor-organic pollutants on a human body:

- in settlements of Chukchi AO where basic actions for rehabilitation of territories were performed according to international-approved recommendations by the results of the project GEF/AMAP, 2001 (Appendix 1);
- in control settlements of Chukchi AO which did not take part in implementation of recommendations of the project GEF/AMAP, 2001.

2. To develop recommendations on application of advanced methods of social and economic estimation of efficiency and planning of the actions directed to protection of population of AZRF against harmful effect of pollutants.

2. Research methods

2.1. Organization of the research

Research report, the program of training of public health employees, and sampling rules were approved by Expert group of human research, founded by AMAP Secretary in Svalbard, Norway, May 6-10,.

2001. The research report also has been approved by Ethics Committee of Pasteur Institute in Saint-Petersburg (international code # T5096).

The following measures have been taken to provide a high level of participation: planning of meetings with heads of local bodies of public health and representatives of local organizations of native people, information by radio; and also personnel of the local hospital visited people at home and invited them by phone.

Before inquiring each participant received the information and gave written informed consent to participation in research.

Survey by questionnaire made among native population, constantly living in Chukchi area, was based on the interviewing report by specially trained personnel and was similar to that was used in AMAP research in 2001 with additional section on estimation of efficiency of the developed recommendations. The report with additions has been approved by Ethical Committee of FGUN "Northwest scientific centre of hygiene and public health".

2.2. Venues of research and a contingent

Medical-ecological examination and questioning of the population was performed in 7 settlements of ChAO, in three of which the actions recommended by AMAP expert group for decreasing of risks of harmful effect of pollution for municipal institutions were performed in full and 4 settlements where these actions were executed in the limited volume.

Settlements of the natives where in 2002-2004 rehabilitation actions and training seminars among the population for the purpose of explanation of danger of persistent toxic substances and preventive measures are carried out:

- sett. Lavrentiya;
- sett. Lorino;
- sett. Kanchalan.

2. Settlements of the natives where in 2002-2004 rehabilitation actions and training seminars were not carried out in full:

- sett. Uelen;
- sett. Enurmino;
- sett. Neshkan;
- sett. Inchoun.

Fig. 3. Municipal union “Chukchi rayon” - settlements included to the pilot project.

Нешкан – Neshkan

Энурмино - Enurmino

Инчоун - Inchoun

Уэлен - Uelen

Лаврентия - Lavrentiya

Лорино - Lorino

Chukchi rayon is located at the coast of Bering Strait. The **area of the rayon is 30.7 thousand sq. km. Today about five thousand people live in area.** The most part of the population of the rayon (83 %) is representatives of the native smaller peoples of Chukotka: Chukchi, Eskimos and others.

Administrative centre of Chukchi rayon is the village Lavrentiya. The municipal union structure Chukchi area also includes national villages Lorino, Uelen, Neshkan, Enurmino, and Inchoun (fig. 3).

Prominent features of this area are **sea hunting, animal breeding, bone carving.** Sea whale, walrus, seal, ugreg hunters are the best on Chukchi Peninsula. Despite difficult economic times on Chukchi Peninsula, fur farmers managed to keep a small amount of polar foxes in villages Lorino and Inchoun. At present the **branch of fur farming is reviving here.** Bone carvers' products of Vukvol bone carving workshop "Northern souvenirs", Uelen, are still are unique and are appreciated not only in our country, but also abroad. Reindeer breeding has started to revive in recent years. Two municipal unitary enterprises of agricultural manufacturers "Keper" and "Zapolyarye" are engaged in this branch.

Chukchi rayon is the most northeast part of Chukchi autonomous okrug and Russia. The settlement Lavrentiya which is the centre of the municipal union Chukchi rayon has been founded in 1927. **The most northeast settlement of Russia is Uelen.** As archeological excavations testify, Uelen is not less than two thousand years. In the beginning of our era there was here a big settlement of walrus, seal, and whale hunters. In territory of Chukchi rayon nearby to the village Inchoun on cape Uten there is the biggest **walrus rookery on Chukotka.** There is an **airport** in the village Lavrentiya which accepts planes and helicopters from Anadyr and other airports of Chukotka. Villages Neshkan, Enurmino, Inchoun, Uelen have basically only helicopter communication. The only earth highway in the area with the stretch of 40 kilometers provides communication with Lavrentiya and Lorino.

2.3. Characteristic of the examined cohort of natives

Table 1.1. Cohort of the inhabitants who took part in examination in 2001 and 2010.

Settlement	Cohort type	Number of the examined in **2001**	Results of the examination in **2010**					
			Number of the invited	Number of the refused	Number of people who changed place of residence	Number of people who has died since 2001	Did not take part in examination (causes are not known)	Number of the examined

Uelen	Adult population (more than 18 years old)	256	256	0	0	47	131	78
	Pregnant women examined in 2001	6	6	0	0	1	1	4
	Their children born in 2001-2002	6	6	0	0	1	1	4
Lorino	Adult population (more than 18 years old)	14	14	0	0	0	0	14
	Pregnant women examined in 2001	14	14	0	3	0	3	8
	Their children born in 2001-2002	14	14	0	3	0	4	7
Kanchalan	Adult population (more than 18 years old)	359	359	0	0	67	215	77

Table 1.1. Continuation

	Pregnant women examined in 2001	6	7	0	0	0	0	7
	Their children born in 2001-2002	6	7	0	0	0	0	7
Ust-Belaya	Adult population (more than 18 years old)	0	0	0	0	0	0	0
	Pregnant women examined in 2001	13	13	0	0	1	5	7

	Their children born in 2001-2002	13	13	0	0	0	6	7
Lavrentiya	Adult population (more than 18 years old)	0	0	0	0	0	0	0
	Pregnant women examined in 2001	5	6	0	0	0	2	4
	Their children born in 2001-2002	5	6	0	0	1	1	4
Inchoun	Adult population (more than 18 years old)	0	0	0	0	0	0	0
	Pregnant women examined in 2001	5	5	0	0	0	0	5
	Their children born in 2001-2002	5	5	0	0	0	0	5
Enurmino	Adult population (more than 18 years old)	0	4	0	0	0	0	4

Table 1.1. Continuation

	Pregnant women examined in 2001	5	5	0	0	0	1	4
	Their children born in 2001-2002	5	5	0	0	0	1	4
Neshkan	Adult population (more than 18 years old)	0	0	0	0	0	0	0
	Pregnant women examined in 2001	8	8	0	0	1	1	6

	Their children born in 2001-2002	8	8	0	0	1	1	6

Table 1.1 Summary table characterizing a cohort of ChAO natives examined within the limits of the pilot project

TOTAL		Number of the examined in **2001**	Results of the examination in **2010**					
			Number of the invited	Number of the refused	Number of people who changed place of residence	Number of people who has died since 2001	Did not take part in examination (causes are not known)	Number of the examined
	Total population	629	629	0	0	114	346	169
	Pregnant women examined in 2001	62	62	0	3	3	13	44
	Their children born in 2001-2002	62	62	0	3	3	14	43

Table 1.2. Actions realized in native settlements of municipal union "Chukchi rayon" to decrease the influence of persistent toxic substances according to AMAP recommendations.

Name of actions	**Budget of the actions, thous. roub.**
Sanitary clearing of territory of settlements	2 300
Installation of local water-purifying units for improvement of potable water quality	540
Organization of periodic quality control of separate kinds of traditional foodstuff	3 600
Decrease in emissions and dumps from economic activities	1.070
Improvement of the material base of medical institutions rendering medical aid to native population	4 760
Collecting, organization of safe storage and recycling of waste potentially polluted with PTS	5 700
Teaching of native population to measures on	2 100

prevention of harmful influence of PTS	
TOTAL	20.070

Table 1.3. Volume of realization of actions for decrease in risk of the harmful influence of PTS, performed according to recommendations of AMAP expert group

Performance of main actions in % of the recommended	**List of taken actions**	**Areas where actions were carried out**
Actions executed in full	1. Actions for prevention of ground pollution with toxic substances in the territory of settlements of native people. 2. Sanitary clearing of the territory: collecting, neutralization, transportation, storage of potentially dangerous waste. 3. Actions for prevention of contamination of dwellings with dangerous chemical substances 4. Protection of water objects, potable water and drinking water supply. 5. Restriction of consumption of potentially contaminated traditional food. 6. Hygienic education (training seminars for medical personnel and population)	Set. Kanchalan
Actions executed partially (no more than 50 %)	1. Sanitary clearing of the territory: collecting, neutralization, transportation, storage of potentially dangerous waste. 2. Protection of water objects, potable water and drinking water supply. 3. Restriction of consumption of potentially contaminated traditional food. 4. Hygienic education (training seminars for medical personnel and population).	c. Set. Lorino Set. Lavrentiya
Actions executed partially (no more than 20%)	1. Restriction of consumption of potentially contaminated traditional food. 2. Hygienic education (training seminars for medical personnel and population).	Set. Uelen Set. Neshkan Set. Enurmino

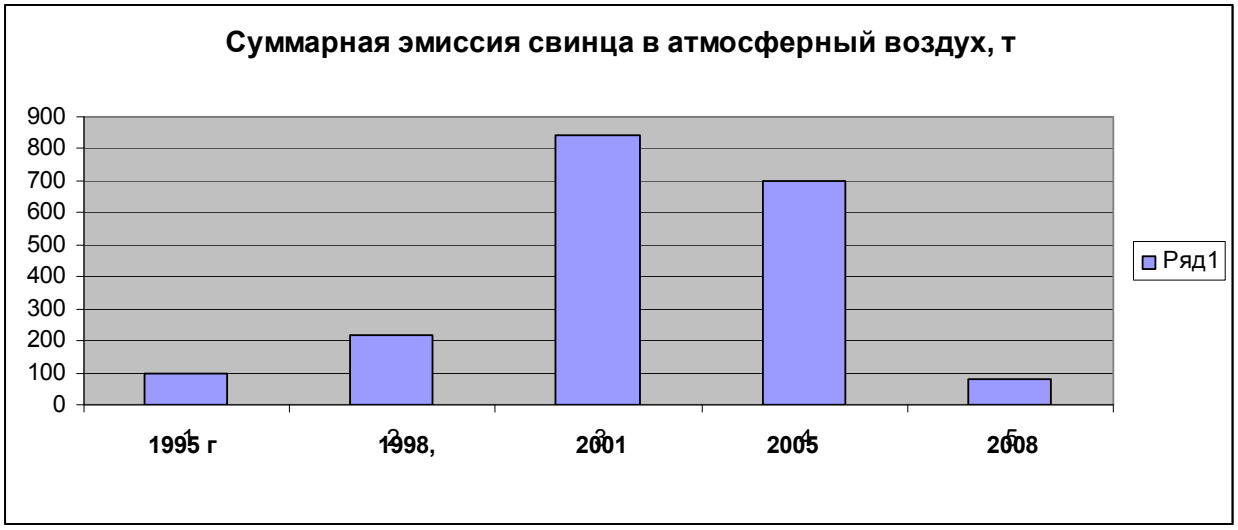

Figure 4. Lead emission from organized sources (without vehicles) in ChAO.

2.4. Investigated substances

Measurements of PTS concentration in the selected blood samples, and also swabs and scrapes from internal surfaces of building structures of dwellings in the investigated cohort, were carried out in laboratories having international accreditation on competence within the limits of the program of AMAP standardization and quality control.

In total the following substances were defined under the report:

PCB (15 PCB congeners 28/31; 52; 99; 101; 105; 118; 128; 138; 153; 156; 170; 180; 183 and 187);

Hexachlorcyclohexans (α, β, γ - HCH);

Oxychlordan; trans-chlordane, cis-chlordan;

DDT (2.4 DDE; 4.4 DDE; 2.4 DDD; 4.4 DDD; 2.4 DDT; 4.4 DDT)

Hexachlorobenzene

Heptachlor

Dieldrin

Mirex

Trans-nonachlor, cis-nonachlor

Toxaphenes (Par 26; Par 50; Par 62)

PBDEs (7 PBDE congeners 28; 47; 100; 99; 153; 154; 183)

Metals (Cd, Pb, Hg) in whole blood

Lipids

Each selected blood sample (30 men and 30 women) was analyzed for the content of 15 PCB congeners: 28/31; 52; 99; 101; 105; 118; 128; 138; 153; 156; 170; 180; 183 and 187, groups of pesticides, including hexachlorcyclohexane (HXB); oxychlordans; DDT (including its 6 metabolites); hexachlorobenzene; Heptachlor; Dieldrin; Mirex; trans-nonachlor; cis-nonachlor; toxaphenes; and also metals (Cd, Pb, Hg,) and lipids.

2.5. Blood sampling

Blood sampling was performed in parallel with a survey about meals character /way of life in which 2 groups of respondents participated: pregnant women whose blood (and also blood from an umbilical cord) was sampled when they were in delivery wards of local hospitals, and also representatives of general female native population.

Trained medical personnel selected samples from the elbow vein of a mother and from an umbilical cord during stay of women-natives in Lavrentiya delivery ward. Blood was selected with the help of vacutainers. For the subsequent processing of blood special pipettes and test tubes which have been checked up for absence of possible polluting substances were used. For plasma separation centrifuge A of 3000 rpm was used. Both plasma samples and blood samples were stored in the freezing chamber at -30°C. The frozen blood samples were transported to the laboratory in special thermoisolated containers.

However, because of non-observance of the report transportation requirements, a number of blood samples which have been taken from male native population at the 2nd investigation phase have been delivered to SZNTS laboratory partially defrozen. About 6 samples have decreased in volume to critical level because of a leak in the course of transportation in the plane. It was revealed that measured concentrations of PCB and DDT were below detection limits. It has

compelled us to exclude PTS measurements, concerning these people (ID 711017,1; 711037,1; 711003,1; 711043,1; 711053,0; 711034,1; 711054,0).

The analysis of blood samples for PTS definition is based on GC/MS methods. All samples were analyzed in series. Each series did not include more than 12 samples, an also blank sample and a control sample containing certain quantities of analytes. Use of isotopic-marked artificial standards has provided validity and accuracy of measurements: introduction of analytes analogues to the samples before extraction.

2.6. Analytical methods

2.6.1. Definition of steady organic compounds (SOC)

SOC extraction from blood serum.

Before extraction blood serum samples were defrozen at a room temperature. Each serum sample was weighed within the accuracy of 0.01 g and was placed into a laboratory flask. Then a solution with isotropic marked artificial standards was added and mixed up within 30 minutes, then methanol was added (in the volume equal to sample volume), and the solution was mixed up within one more minute. At first solutions with samples were extracted by means of a mix 1:1 hexane-MTBE (methyl-tri-butyl ether), extraction process was repeated twice, with use of 20-35 ml of extractant. After separation of organic and water layers, the extract was transferred to an Erlenmeyer flask by means of a pipette. Extracts were mixed, and the remained water was removed by means of waterless sodium sulphate within 30 minutes. Then the extract went through a fiber glass filter and was brought to the volume of 10 ml with the help of a rotor evaporator.

To define the level of lipids in blood serum 2 ml of aliquot extract was used. Then the remained extract again was brought to concentration of 1 ml, was cleared from lipids with the help of gelular filtration on Bio-Bead SX-3 column, and impurities were separated by means of activated aluminum oxide and column chromatography with silica gel Florisil and coal AX-21 columns.

2.6.2. Definition of polychlorinated xenyls

PCB was extracted in the way described above. Before extraction an artificial standard (a mix of isotopic marked kinds EC-4058 Cambridge Isotope Laboratory - CIL) was added to each sample. Before measurement by means of devices an internal standard for checking recovery (**ISR**) was added to the extract in the amount of 1 ng PCB #166.

The analysis was performed by means of *GC/MS Varian Saturn 2200 T.*

Device calibration was made by means of a standard mix of biphenylss BP-MS, Wellington Laboratories. Linearity of the device was checked by calibration by five points in the range of concentration from 1 to 200 ng/ml. After the analysis of the analytical series calibration was checked by measurement of a standard solution of average concentration. Results of measurements were processed by means of software Varian 5.2.+

S**eparate PCB congeners** were defined by means of a mass spectral analysis and confinement time, of separate PCB congeners.

Concentration of separate PCB congeners C_n, mkg/l was calculated with the help of measurement of signals for each separate congener by the formula:

$$C_n=(S_n)m_r/(S_r)(RRF)_n(REC)_s\,M$$

where S_n – a peak zone of this PCB congener;

S_r – ISR peak zone;

M – sample weight, l;

m_r in the volume of the loaded ISR, mkg;

$(RRF)_n$ – relative reaction factor for separate PCB congener;

$(REC)_s$ recovery coefficient of the corresponding artificial standard;

$(RRF)_n$ is defined by means of the analysis of PCB metering solutions:

$(RRF)_n= (S_{ns})m_{rs}/(S_{rs})m_{ns}$

where: S_{ns} – a peak zone of the given kind of PCB in the metering solution;

S_{rs} peak zone for recovery in a metering solution;

m_{ns} – quantity of PCB congener in a metering solution, ng;

m_{rs} – recovery in a metering solution, ng.

Extraction coefficient for the artificial standard is defined by the formula:
$(REC)_s = (S_{sur})m_r/(S_{rs})m_s(RRF_{sr})$

where: $S_{sur\ a}$ zone of the artificial standard in the analyte;
S_{rs} recovery of the standard in the analyte;
m_s – amount of the load artificial standard in analyzed sample, ng;
m_r – amount of the added ISR, ng;
$(RRF)_{sr}$ –relative reaction factor for the artificial standard:

$RRF_{sr}=(S_{surs})m_{rs}/(S_{rs})m_{sur}$

Where S_{sur} and m_{sur} - a peak zone and artificial standard concentration the in PCB metering solution, respectively.

PCB concentration was calculated with the help of extraction coefficient of artificial isotropic-marked PCB congeners for each group, depending on chlorination degree.

Acceptance criterion

Content of separate PCB congeners in a blank sample: less than 1 ng.

Defined content of PCB congeners in a control sample: 75-120 % of the load quantity.

Extraction range of the artificial standard (extractibility): 50-120%.

2.6.3. Quality of the tool data for PCB

Sensitivity of the device was defined once a day (or after device adjustment) by means of the analysis of standard PCB metering solutions.

Criterion of admissible quality: Ratio "signal-noise" - more than 3:1 for 0.001 ng ^{13}C-PHB # 180 in the loaded volume.

Chromatographic resolution was checked by means of the analysis of metering standards, performed before and after the analysis of an analytical series of samples. *Admissible values:* full separation of peaks of PCB #74 and PCB #70

Mass spectrometric resolution defined during automatic adjustment of the device for ions m/z=264 and 265 as R=1/pound where 1 is a distance between centers of the peaks, b –half-width, not less than 0.95.

Linearity of device calibration was defined by means of the analysis of 5 standard PCB solutions with concentration from 1 to 200 ng/ml.

Quality factor - admissible standard deviation of the design relative reaction factor (RRF) should be less than 20 %.

Technical characteristics of the device were checked before and after the analysis of a series of samples by means of analysis of PCB metering solution of average concentration.

Quality factor– difference of ККА values calculated before and after the analysis should be no more ±than 15 %.

Check of possible contamination of the device with analytes was made after each analysis of a metering standard solution by hexane introduction. It allows to make sure that analyte signal in a sample is not caused by the previous sample.

Acceptance criterion– value of the error created by a background of the device should not exceed 1 % of the average value of defined concentrations.

2.6.4. Definition of organochlorus pesticides (OCP)

The following compounds were analyzed among organochlorus pesticides:

hexachlorobenzene; α-HCH; β-HCH; γ-HCH; 4,4 ’-DDE; 4,4 ’-DDD; 4,4 ’-DDT; 2,4-DDE; 2,4-DDD; 2,4-DDT; toxaphene compounds: Parlar-26, Parlar-50, Parlar-62; heptachlor; cis-chlordan; trans-chlordane; oxychlordan; dieldrin, mirex, and in addition to the technical project – cis - and trans-nonachlor.

OCP were extracted in the way described above. Before extraction an artificial standard (a mix of isotopic marked congeners EC-4058 Cambridge

Isotope Laboratory - CIL) was added to each sample. Before measurement by means of the device ISR was added to the extract of 1 hg PCB #166.

The analysis was performed by means of *GC/MS Varian Saturn 2200 T.*

Device was calibrated by means of measurement of standard solutions of chlorinated pesticides Promochem. Linearity of the device was checked by calibration by five points in the range of concentration from 10 to 500 ng/ml. After the analysis of the analytical series calibration was checked by analysis of a standard solution of average concentration. Results of measurements were processed by means of software Varian 5.1.+

Definition of chloric pesticides performed on the basis of mass spectral analysis and confinement time of chloric pesticides.

Concentration of organochlorus pesticides C_n, mkg/l was calculated by measurement of signals for each separate compound as it is described above.

The limits of detection defined statistically with probability of 95 % in a series of double analyses of blank samples were in the range from 0.003 to 0.03 mkg/l of the serum for various OCP.

The analysis of samples was carried out by series. Each lot included 12 samples; control sample was prepared in CEC and in a blank sample. The mix of marked standards produced by CIL (USA) was the artificial standard.

$^{13}C_{12}$ p,p'-DDE

$^{13}C_{12}$ p,p'-DDT

$^{13}C_6$ γ-HCH

$^{13}C_6$ Hexachlorobenzene

Recovery standard was PCB # 166.

Acceptance criterion

OCP content in the blank sample – less than 0.005 mkg.

Analyzed OCP were extracted from control sample CEC within 70-120 % for 90 % of the compounds added to the sample. Extraction range of the artificial standard was 50-12 %.

2.6.5. Quality rating of devices for OCP

Sensitivity of the devices was defined once a day (or after device adjustment) by means of the analysis of standard OCP metering solution.

Criterion of admissible quality: Ratio "signal-noise" - more than 3:1 for 0.002 ng hexachlorobenzene in the loaded volume.

Chromatographic resolution was checked by means of the analysis of metering standards, performed before and after the analysis of the analytical lot.

Mass spectrometric resolution: was defined during automatic adjustment of the device for ions m/z=502 and 503 as R=1/pound where 1 is a distance between centers of the peaks, b –half-width, not less than 0.95.

Linearity of device calibration was defined by means of the analysis of 5 standard OCP solutions with concentration from 10 to 500 ng/ml.

Quality factor - admissible standard deviation of the design relative reaction factor (RRF) should be less than 20 %.

Technical characteristics of the device were checked before and after the analysis of a series of samples by means of analysis of OCP metering solution of average concentration.

Quality factor– difference of KKA values calculated before and after the analysis should be no more ±than 15 %.

Check of possible contamination of the device with analytes was made after each analysis of a metering standard solution by hexane introduction. It allows to make sure that analyte signal in a sample is not caused by the previous sample.

Acceptance criterion– value of the error created by a background of the device should not exceed 1 % of the average value of defined concentrations.

2.6.6. Definition of toxaphenes

The analysis of toxaphenes in blood serum was made for those compounds which are known as the steadiest and wide-spread in the environment, namely: octa - and nona-chloric toxaphenes which are usually called Parlar-26, Parlar-50 and Parlar-62. Extraction of toxaphenes was carried out together with others OCP as it is described above. After preparation the extracts were analyzed by means of GC/MS, working in a mode of chemical ionization, with definition of negative ions, characteristic for toxaphene compounds, i.e. is selective-ionic monitoring (SIM) was carried out. Analyses were made with the device SATURN-1200 MS/MS. Analytes were revealed by presence of characteristic ions and by coincidence of chromatographic confinement time. Because of insufficient quantity of available isotopic-marked compounds, calculations were made with application of external calibration on the basis of the analysis of standard solutions with mixes of separate toxaphene congeners, TOX-482, produced by Promochem.

The limit of detection of separate toxaphene congeners was in a range from 0.01 to 0.03 mkg/l.

2.6.7. Definition of lipids

The content of lipids in serum samples was defined in extract aliquot (20 % of the volume) before chromatographic clearing of the sample extract.

If the weight of the serum sample was less than 2 g the content of lipids was defined by means of the first eluate fraction, spent during clearing of the sample extract from lipids on chromatographic column with Bio-Beads.

Aliquot 2.0 ml was selected from the extract brought earlier to the volume of 10.0 ml and was placed on preliminary weighed aluminum substrate. Substrates with extracts were left in the dry box at a room temperature in order solvent has evaporated approximately in 15-20 minutes. Then substrates were put into the drying box at the temperature of 105°C. After cooling in an exsiccator substrates with lipids were weighed. Content of the lipids in the analyzed sample (%) was defined by the formula:

$$\%L_p = 5 \cdot \frac{M_{T+L} - M_T}{M_S} \cdot 100$$

Where M_{T+L} is a weight of a substrate with lipids

M_T is a weight of an empty substrate

M_S – sample weight

2.7. Control provision and quality control (CP/QC)

Internal program CP/QC in the analysis of serum samples for polluting substances included the control of possible pollution of the samples during preparation of samples and during measurements.

The analysis was made in lots. Lots were formed according the matrix type of a sample and the way of sample preparation. Each lot included 12 samples max., a blank sample and an enriched matrix or an enriched blank sample with the known content of analytes. Recovery of analytes was controlled with the help of isotopic marked analogues of the defined analytes as it is described in corresponding manuals on analytical methods.

2.7.1. Recovery of artificial internal standards (AIS)

PCB

Artificial internal standard is a solution made by Cambridge Isotope laboratory EC-4058, containing $^{13}C_{12}$ - PCB #28, #52, #101, #138, #153, #180. 2.5 ng of each congener was added to the samples. Recovery degree of AIS in analytical lots was in a range of 38-110 % that corresponds to quality criteria for PCB analysis. PCB concentrations were calculated with the account of recovery of artificial standards in a sample.

OCP

As the artificial standard, a solution prepared in CEC, using standards of Cambridge isotope laboratory was used. 2.5 ng $^{13}C_{12}$-p, p ’-DDE, $^{13}C_{12}$-p, p ’-DDT,

$^{13}C_{12}$ – lindane and $^{13}C_{12}$ – hexachlorobenzene were added to the samples. It was found that the average recovery degree of AIS is in a range 42 - 99 % that corresponds to quality criteria for OCP analysis. Concentrations of hexachlorobenzene, DDE, DDT and hexachlorcyclohexane were calculated with the account of artificial standards recovery in a sample.

3. Priority external risk factors of ditiriation of health of the population and characteristic of changes in intensity of harmful PTS influence on an organism and their influences on health indicators and formation of demographic processes.

3.1. Risk factors connected with anthropogenic pollution of habitat in Arctic regions

As it is mentioned above in our researches, during medical-ecological estimation of pollution sources and the risk of harmful influence on population health connected with them it is necessary to consider three main classes of factors connected with natural-climatic features of the Far North:

Main sources of industrial pollution are presented by enterprises for extraction and enrichment of polymetallic sulphidic ores, and also for their pyro- and hydrometallurgical processing. In the course of refinement only 30 % of all sulphur containing in furnace and converter gases, is utilized in the form of sulfuric acid manufacture of which makes one of principal types of production of nickel industrial complexes.

Proceeding from total amount of world industrial emissions of SO_2 making about 90 million tons a year, contribution of Russian nickel enterprises located in the Far North, does not make less than 2.5 %.

Among solid compounds, in environmental contamination insoluble compounds of nickel, copper and cobalt have the greatest value emissions of which

during 1996-2000 are estimated as follows: Nickel –1607.81 to 1779.91 tons a year, copper –876.84 to 1096.44 tons a year and cobalt –46.05 to 51.31 tons a year. At the same time, content of metals in atmospheric air of a city does not exceed average and maximum allowable concentrations.

In this connection, workers of the specified manufactures reveal earlier pathology which in usual conditions proceeds favorably. Extensive medical supervision made both in our country, and abroad, allow with sufficient degree of reliability to define character and measure of influence of climate and geographical conditions on morbidity of the population. Cold, being one of extreme factors of natural and environmental conditions of the Far North, during its influence on an organism causes strengthening of toxic effects of some chemical substances. It is firmly proved by a number of hygienic researches in the case of fluorides, carbon monoxide, and dust. It results considerable losses of labor, early disability, and increase of other indicators of general and professional diseases that undoubtedly has enormous negative social and economic consequences.

Infant mortality is the quality indicator of social and economic development of a society or separate populations, reflects the levels of education, culture, environmental contamination, level of organization of medical aid and its availability.

The most important indicator characterizing infant mortality is neonatal mortality - death rate of children of the first month of life. This period has the majority of death of the first year of life, and the maximum quantity of deaths occurs in the first week (early neonatal mortality), and the first week - in the first days of life.

The maximum part of deaths as a result of congenital malformations (31.3 %) is noted among children of the cities located in areas of placing of the enterprises of mountain-extracting and nickel industry (rate of mortality 5.5 – 4.6.). This indicator 2 times exceeds expected level at the average. Thus special epidemiological analysis of investigation results of death rate among children to 14 years (case-control) has shown that children who were born from mothers, working at enterprises of nickel industry, have the raised relative risk of death from

congenital malformations, characterized by average index RR = 2.8 (confidence interval 1.7 – 5.4) and death from malignant neoplasms RR = 4.4 (1.8 – 7.3). Statistic analysis of the data of clinic registration of people, suffering from the most widespread chronic diseases, testifies to rather essential distinctions in disease level between population living near different enterprises. These distinctions in many nosological forms of diseases reach 2 and more times.

Prevalence of chronic diseases among adult population is also at the raised level in these areas though, of course, distinctions are not so considerable as among children. From 1.5 to 3 times above expected indicators there are blood diseases (mainly hypochromic anemia), chronic bronchitis and pneumonia, malignant neoplasms, skin diseases.

3.2 Socio-economic risk factors

In Soviet period Russia possessed the largest herd of house reindeers reaching 2.3 million of animals that made three quarters of a world livestock. Reindeer breeding as an economy branch was considered rather profitable. Sea hunting has developed as the main traditional employment for the native smaller peoples inhabiting at coasts of the Arctic and the Pacific oceans. First of all, it is Eskimos, Aleuts, coastal Chukchis and koryaks. To a lesser degree this trade was spread among Nenets, Evens and other peoples. Objects of hunting are whales, walruses and seals that provided communities of the natives with meat, grease and skins.

Deterioration of a demographic situation in northern regions of Russia — an indicator of change of the environment inhabitable quality, decrease of harmony and stability of the anthropoecosystem of the North. Population forecasts predict further development of negative processes by 2020.

Now there is a decrease of viability of the population in the north. It is especially expressed among the native population. By the time of North industrialization the condition of inhabitancy and traditional kinds of activity of the population have been at the maximum peak of possibilities of northern nature management which was historically inevitably followed by recession. At this stage

nomads have been moved to settlements without water supply system, water drains, central heating, water intakes, with undeveloped social infrastructure and poor supply with food and industrial goods. Vital interests of the native population were ignored; its opinion was not counted at mining operations, gas oil production, construction of pipelines, explosions in Arctic regions. As a result there was sharp decrease in indicators of life expectancy.

Thus, intensive economic natural resources development of northern regions of Russia since 60th years has led to change of the status of native ethnos. As a result of breaking of ecological balance of the territories there was a reduction of the areas, suitable for traditional managing.

Resettlement of native national groups in settlements has affected negatively an occupation level and work motivation of native national groups. The new setting system has been adhered to places of intensive development of fuel and energy resources and was poorly oriented to traditional natural management.

With transition to market economy the quantity of the people occupied in manufacture, began to reduce. This process affected 21 peoples of the North of 30. Number of the occupied Eskimos (-30.9 %), Chukchi (-28.6 %), Lapp (-22.1 %), Itelmen (-19.5 %) was sharply reduced. The number of the occupied natives has decreased almost by 10% over the last 10 years. As a result today up to 25-39 % of an able-bodied aboriginal population are almost jobless. Many of them have occasional means of subsistence at the expense of seasonal work, first of all gathering of wild plants, fisheries, hunting. The rate of unemployment among youth and women is especially great.

Narrowing of a work sphere of an aboriginal population leads to loss of interest from youth to traditional kinds of labor activity, native trades, production of national crafts. Marginal groups which have lost interest to work are growing, 15 % of the able-bodied do not want to work in general, threat of the further social degradation is real.

Worsening position of the smaller peoples of the North on a labor market is connected with their low general educational level. From the native population older than 15, 48 % have elementary and incomplete secondary education, 16.9 %

— do not have elementary education, and half of them is almost illiterate. It does not allow them to master modern trades, leaving them time and seasonal works.

Problems of rational integration of the native people in a modern society at preservation of traditional kinds of work and a lifestyle still stand sharp.

Таблица.1.3 Per capita cash income of native population*

Region	Men	Women
Chukchi AO	33261.4	29004.9
Murmansk region	40093.5	39199.3
Nenets AO	25367.2	27630.8
Taimyr AO	70504.6	75742.8
Average in Russia	62628.0	50017.8

* - according to the data of All-Russia population census (2002)

Fall in education level, and reduction of one of integrated indicators of economic well-being – cash incomes per capita of the native population, inevitably involves transition to food consumption from local sources, in particular sea animal and fish which make about 90 % of a nutrient budget in families with the lowest level of cash income according to questioning (Tab. 1.3).

Essentially, that exactly these products rich in grease (13-28 %) are, according to our researches (AMAP, 2004), the main way of receipt of fat-soluble high-toxic chlororganic compounds included into the list of substances, forbidden by Stockholm Convention. As it is obvious from the data introduced in the table 1.4, there is an inverse relationship between the content of these substances in blood (except for DDT) of aboriginals and levels of their cash income and education.

Table 1.4. Correlation factors between the content of harmful toxicants in blood of the natives of Arctic regions and the monthly average cash income for one member of a family, and also an educational level (by the number of training years), mg/l

Persistent toxic substances	Per capita income	Number of training years

PCB	-0.322	-0.208
Arochlor 1260	-0.353	-0.203
Chlordans	-0.276	-0.067
DDT	0.243	0.206
Hexachlorobenzene	-0.458	-0.200
Toxaphens	-0.319	-0.091
Cd	-0.264	-0.184
Pb	-0.078	-0.660
Hg	-0.287	-0.245

3.3. Other natural-climatic risk factors

For the Far North, original photoperiodism is characteristic: short daylight hours in the winter and long - in the summer period. Besides absence of solar illumination with its purifying influence on atmosphere during the winter period, calms in the conditions of anticyclones during which ground thermal inversions and accompanying them smog are formed, are frequent. Total number of days with a calm - about 25 %, especially often they are observed in December-March (to 90 %).

Conditions of negative heat balance for a person performing work with admissible physical activity, last in these areas an overwhelming part of a year - 316 days, together with a big and moderate pressure of thermoregulation (weathers of classes 2 and 3) are characterized on the average by 240 days.

There is one more natural factor which as believe, may have an essential impact on a human body in the Far North. Such factor is geomagnetic storms and phenomena accompanying them. This fact is recognized by many leading experts studying influence of natural factors of the Far North on people's health. Among them the academician of the Russian Academy of Medical Science V.P.Kaznacheev, T.I.Andronova, V.V.Boriskin, etc. (2002). This statement is

based on the results of numerous researches of many years. It has been authentically established that strong or average correlation with storminess of a magnetic field of the Earth is shown by following physiological parameters: 17-ketosteroids (correlation is very strong), activity of chlorine esterases, vitamin B_1 in urine (correlation is strong), skin temperature, blood-flow, minute blood volume, maximum arterial pressure, pulse pressure, pulse, hemoglobin concentration, blood oxygen capacity, ESR.

Low-mineralized waters ("soft" water) are characteristic practically for all regions of the North. The analysis of a microelement composition of water testifies to the low content of zinc and fluorine. Water composition is one of the important environmental factors in the north having a powerful influence on people's health.

Regions of the Far North are characterized by the variety of chemical composition of soils and waters. For a considerable part of regions potable water is low mineralized, it is characterized by deficiency of biologically active elements.

In places where water has sufficient mineralization level, indicators of population mortality are lower. Hard water protective action is connected with presence of calcium, magnesium or main microelements in it. Soft potable water has negative influence on the health because of disbalance of basic mineral components, first of all, sodium and calcium.

Undoubtedly that biological importance of changes of a chemical composition of soil, vegetation and water can act as one of risk factors of health disorders among the population. This should be considered at the analysis of prevalence of the separate diseases especially having endemic character. So, for example, in the Far North water contains less fluorine, iodine and calcium than a hygienic norm which as it is proved in special researches is the reason of high prevalence adenoma of thyroid and caries.

3.4. Comparative analysis of time tendencies in changes of the content of persistent pollutants in organisms of CHAO aboriginals

Though mass delivery of means and materials containing PTS to Arctic regions has been almost stopped by 2000, however, as it well-known, in territories of economic development of the Russian Arctic regions for the previous period the excessive quantity of unutilized waste posing real threat to environment and population health is saved up. Observable climate fluctuations have already led to quite obvious consequences in the form of intensification of global transfer of pollution to polar areas, change of a hydrological regime of large Siberian rivers and ocean currents, and which is extremely adverse for population health, accelerated mobilization to inhabitancy of hazardous toxic substances and activators of diseases from burial places of industrial and animal waste placed in melting permafrost soils.

Totality of the listed risk factors can devaluate efforts of public authorities and local government on stabilization of morbidity and mortality of the population and as a whole a demographic situation in AZRF that is, as it was already specified, one of the basic strategic problems. It is well demonstrated by the leading territory of this region where large-scale expenses of budgetary and non-budget resources on clearing and organization of safe waste storage, training of the population to measures on prevention of PTS damage effect (see table 1.2). Nevertheless, it is found that women after deliveries observed during 10 years had some decrease in concentration in blood of main kinds of resistant contaminants that it is possible to explain with a well-known phenomenon ”risk transfers” to their neonatal children in the result of 2-year- feeding with breast milk rich in lipids (fig. 5). At the same time men from their families against SOC decrease, arriving to Arctic regions, mainly at the expense of distant (global) transfer (DDT, NSN, HCB, toxaphens), had essential increase in those PTS which arrive in inhabitancy mainly from local sources (PCB, lead) (fig. 6, 7).

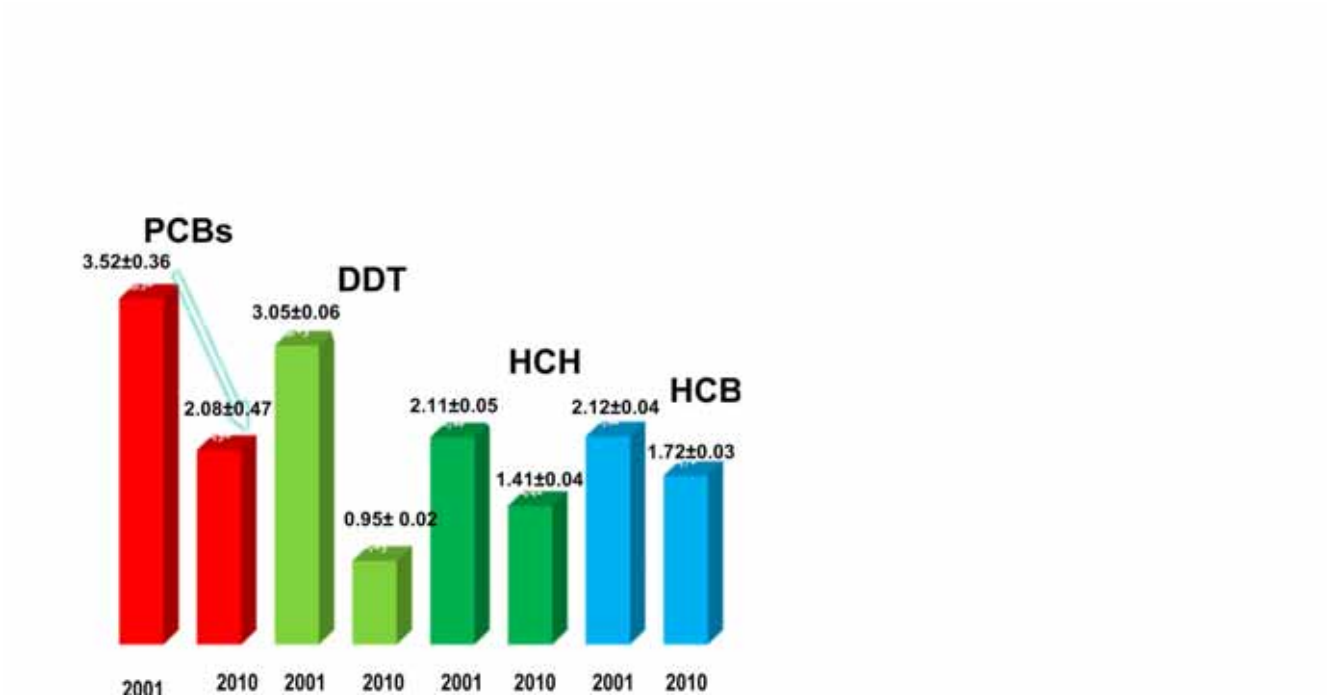

Figure 5. Changes in content of main SOC in blood of the women included in a cohort "mother-child" in ChAO for the ten years' period of supervision (2001-2010)

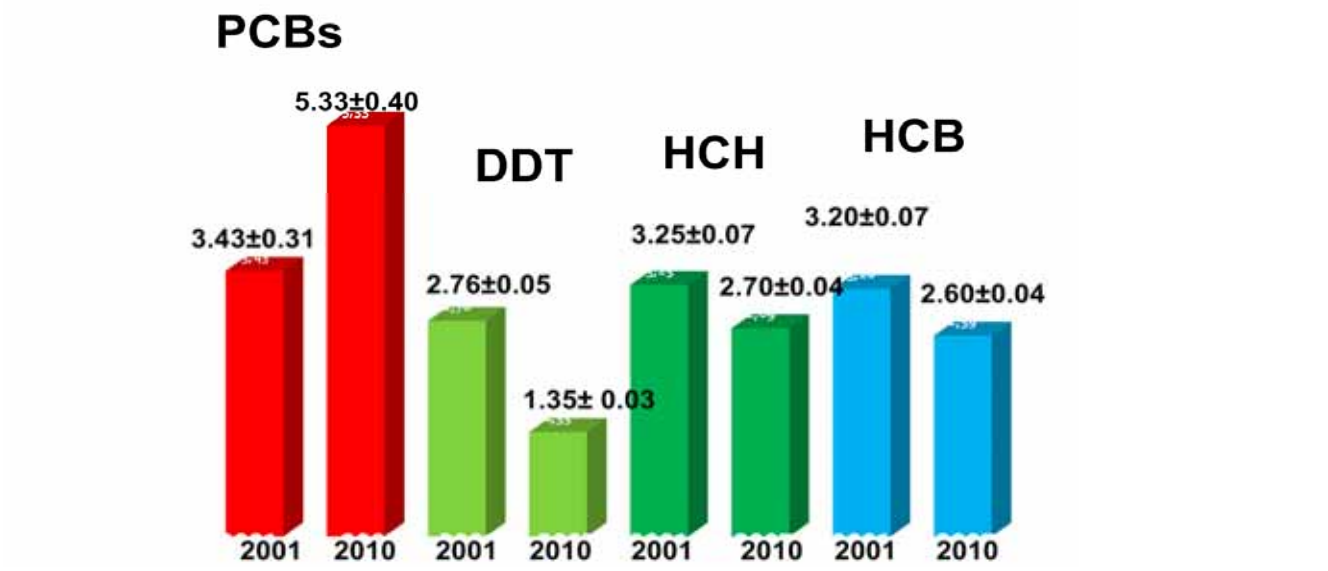

Figure 6. Changes in content of main SOC in blood of the men included in the controlled cohort of ChAO population for the ten years' period of supervision (2001-2010)

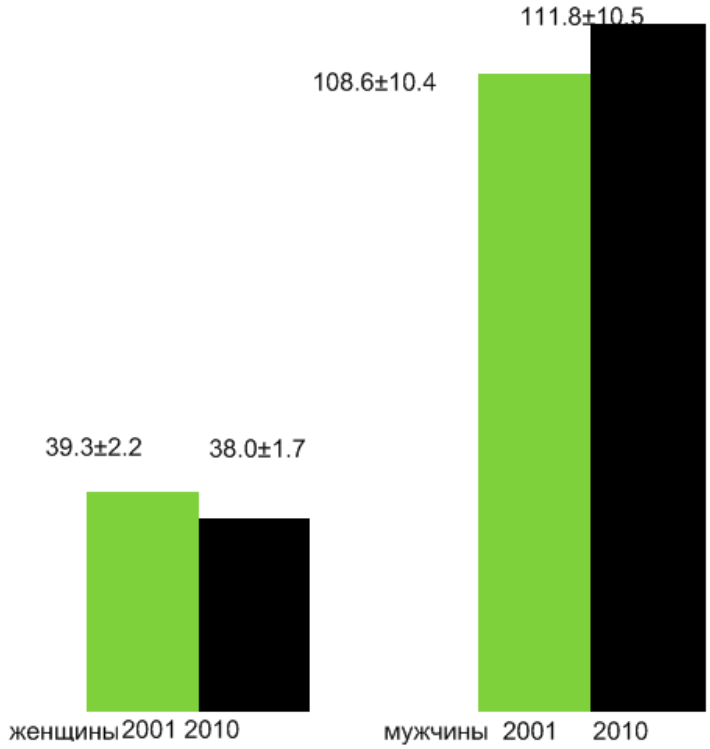

Figure 7. Changes in the content of lead in the whole blood in a family cohort of men and women examined in 2001 and 2010.
Женщины – women
Мужчины - men

Table 1.5. Change of SOC specific content on the internal surface of building structures in the premises occupied by people from the control cohort of the natives

SOC type	Swabs, mkg / m2		Scrapes from walls, ng/g	
	2001	2010	2001	2010
n	10	9	11	9
Σ PCB	2.35±0.36	3.89± 0.45	248.1±4.0	263.3±**40.0**
HCB	0.08±0.02	0.06±0.02	0.8±0.2	0.7±0.2
Σ HXB	0.49±0.07	0.35±0.06	67.4±10.9	59.2±**0.9**
4,4 `-DDE	0.90±0.18	1.23±0.23	126.3±22.1	201.4±**35.7**
Σ DDT	11.19±2.66	6.20±1.85	768.4±106.5	566.9±**98.9**

3.5. Estimate of efficiency of teaching the native population to methods of decrease in risk of PTS damage effect.

As it was already mentioned in this present report, insufficient efficiency of actions for rehabilitation of the territories polluted with PTS, probably, is caused by accelerated "de-preservation" of hazardous waste burials in the result of accruing melting of permafrost soils and change of hydrological regime of water-bearing ways in connection with observable climate fluctuations.

However estimate of awareness of aboriginals about risks and preventive measures gives some representation about other possible reasons of insufficient efficiency of the realized recommendations for prevention of PTS damage effect on an organism. This section of work is given particular attention both in AMAP recommendations (2003), and in documents of other working groups and bodies of the Arctic Council. One of the conditions is trained experts from among representatives of the native people should train them, using thus both scientific data, and traditional experience. In ChAO territory such work was made under direct control and with participation of Association of native smaller peoples of the North (AKMNS) in 2004-2006 by interviews in families and at meeting of inhabitants and distribution of well illustrated booklets explaining hazards connected with pollution of traditional food and ways of their decrease.

During the pilot project the overall performance estimation of training of the population in the form of a test has been performed. Results of this estimation presented in tables 1.6 and 1.7, testify to inefficiency of the training of the population made in 2004-2006 and to necessity of radical change of methods of such work performance which should, in our opinion, have system (constant) character and to be organized beginning with children's collectives (kindergartens, schools).

Table 1.6. Estimation of awareness of the natives of safe methods of trade, storage, processing and preparation of the traditional food potentially polluted with PTS

Points by 5 point system	Number of the examined, %	
	Population covered by training programs (n=98)	Population NOT covered by training programs (n= (n=98)
5 points	2.0	2.3
4 points	21.4	17.2
3 points	24.5	20.6
2 points	20.4	32.2
1 point	31.6	27.7
Average point	2.33±0.05	1.82 ± 0.04

Table 1.7. Estimation of awareness of risk of harmful influence of persistent toxic substances on an organism and effectual measures on its decrease

Points by 5 point system	Number of the examined, %	
	Population covered by training programs (n=98)	Population NOT covered by training programs (n= (n=87)
5 points	2.1	3.4
4 points	2.1	8.0
3 points	6.2	25.3
2 points	68.0	28.7
1 point	21.6	34.6
Average point	1.96 ± 0.03	3.00 ± 0.05

3.6. Estimation of change of general indicators characterizing health of the population

The analysis of changes in the condition of population health of ChAO population also specifies that, despite the executed actions for introduction of AMAP recommendations (2003), for the analyzed period of time there was no essential decrease in indicators of death rate and birth rate increase, on which international experts counted developing out recommendations for the native population of AZRF exposed to superfluous risk of PCB harmful influence (figures 8 and 9).

Diagram 8.
General factors of birth rate in Chukchi AO for 2002-2009
(Number of born per 1000 people)

Diagram 9

General factors of death rate in Chukchi AO for 2002-2009
(Number of the died per 1000 people)

Moreover, the cumulative trend calculated by indicators of changes of frequency of diseases associated with harmful influence of these pollution among ChAO population appeared much less expressed, than indicators of diseases which as experts consider, are not connected with similar influence (ATSDR 2002) (fig. 10 and 11).

Change of indicators by separate nosological forms of diseases included in calculations of trends, are presented in figures 12 and 13.

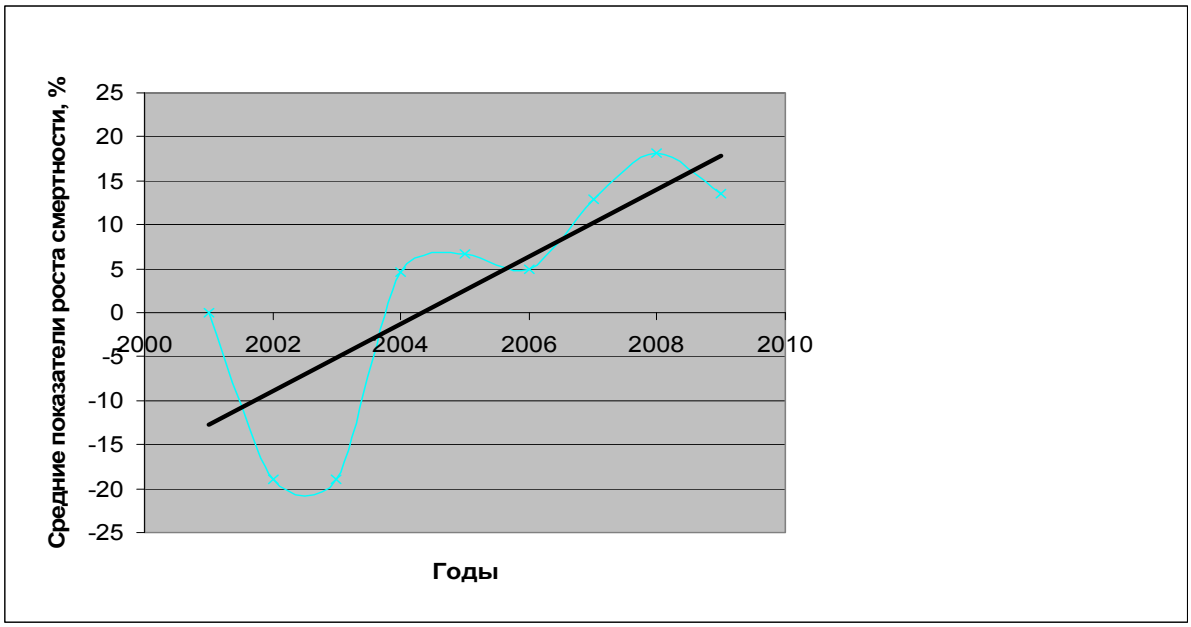

Figure 10. Average annual cumulative trend of changes of frequency of cases of diseases connected with PCB harmful effects (ChAO) to the level of 2001, %%.

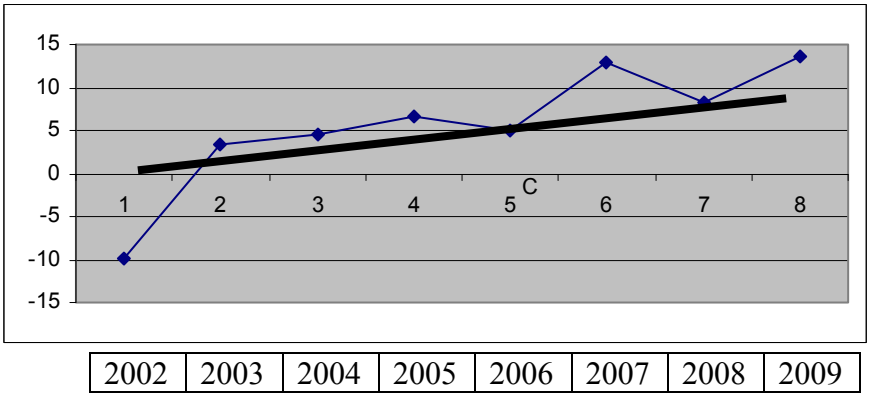

Figure 11. Average annual cumulative trend of changes of frequency of cases of diseases not connected with PCB harmful effects (ChAO) to the level of 2001, %%.

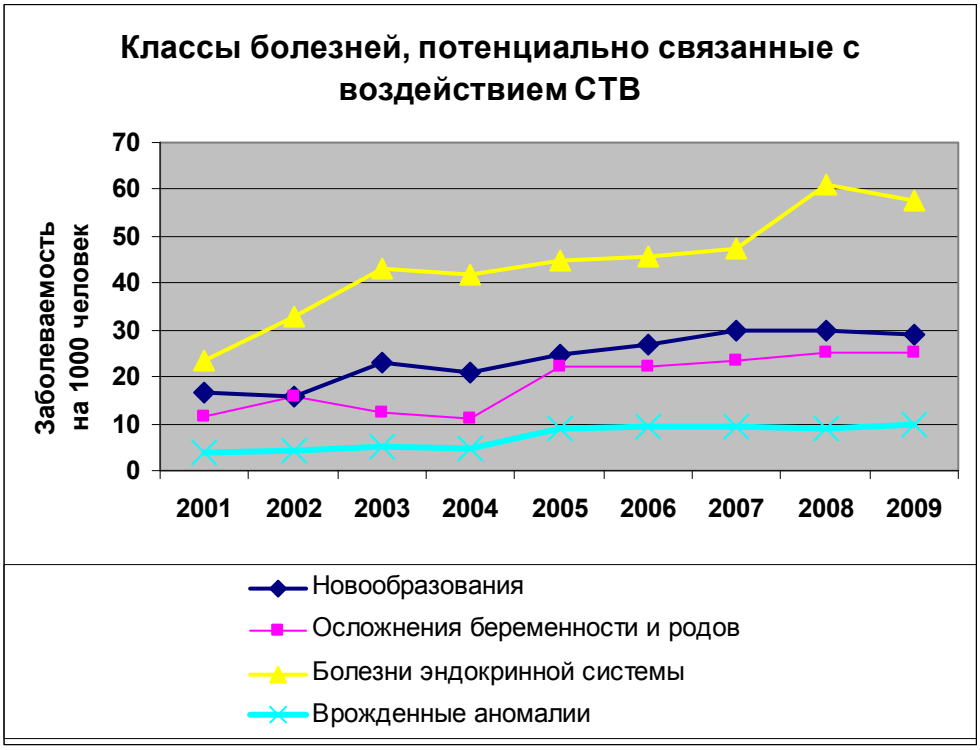

Figure 12. Average annual indicators of frequency of diseases potentially connected with PCB harmful influence.

Новообразования – Neoplasms

Осложнения беременности и родов - Complications in pregnancy and birth

Болезни эндокринной системы - Endocrine system diseases

Врожденные аномалии - Congenital anomalies

Figure 13. Average annual indicators of frequency of diseases which potentially are not connected with PCB harmful influence.

Болезни кожи и подкожной клетчатки - Skin and hypodermic tissue diseases
Болезни костно-мышечной системы - Musculoskeletal system diseases
Болезни органов пищеварения - Digestive apparatus diseases

Table 1.8. Progress of pupils of elementary school of Chukchi rayon from the controlled cohort, in connection with realization of the recommended actions for decrease in risk of PCB harmful influence on an organism

Indicators	Regions where actions were performed (n=48)	Regions where actions were not performed (n=36)	Units of measure
Average PCB concentration in umbilical blood among newborns in 2001	1.72±0.51	2.1±0.72	microgram/L
Average progress at school among pupils of 2 year (2010)	3.5±0.12	3.2±0.14	Points by 5 point system
Average progress at school among pupils of 2 year with PCB concentration at birth <1 mcg/lip	3.63±0.17	3.33±0.23	Points by 5 point system
Average progress at school among pupils of 2 year with PCB concentration at birth >1 mcg/lip	3.45±0.24	3.13±0.20	Points by 5 point system

4. Recommendations on application of advanced methods of social and economic estimation of efficiency and planning of the actions directed to protection of population of AZRF against harmful effect of pollutants.

Generalization of the results of our own researches and the meta-analysis of the data published in the scientific literature, allows to draw quite a certain conclusion that both the structure, and prevalence of various ditiriation of health among inhabitants of the Arctic regions essentially differ as from national, and in particular from average world indicators.

These indicators, to a certain extent, are connected with two main groups of the external risk factors specific to the Arctic regions which should be considered first of all at planning of rendering of medical aid as a whole for AZRF:

4.1. Harmful factors to reduce intensity of influence of which it is impossible now or it is economically inadvisable:

4.1.1. Natural climatic:

- low temperatures and low absolute humidity of atmospheric air;
- high wind force and infrasonic pressure;
- big fluctuations of the geomagnetic field;
- deficiency of solar insolation;
- high repeatability of anticyclonic types of weather (high pressure systems) with calms and temperature inversions in the surface atmosphere worsening conditions of dispersion of harmful substances in the atmospheric air;
- long period of snow cover, capable to accumulate significant amounts of harmful substances which are dropping out with precipitation;
- low temperatures of ground surface reducing speed of sedimentation of aerosols from the surface layer of atmosphere;
- limited mobility of soil solutions;
- limited circulation of surface water;
- lowered speed of physical and chemical reactions defining destiny of pollutants in the environment (dissolution, hydrolysis, oxidation, etc.);
- lowered activity of biota, including processes of biological degradation and assimilation of chemical substances under natural conditions.

4.1.2. Anthropogenic:

- global transfer and accumulation in ecosystems of persistent toxic substances as a result of specific atmospheric circulation, river drains, ocean currents;
- High content of highly toxic substances in some migrating kinds of sea fish and sea animals, and also in kidneys and other internals of a deer).

- It is obvious that abilities of primary prevention and prevention of harmful action of the factors set forth above are rather limited, if at all are possible. Therefore for the purpose to increase efficiency of expenses for the public health care of people, living in ecologically unfavorable areas of AZRF, it is expedient to include the factors harmful effect of which can be reduced essentially or to compensate with measures of medical prevention to the number of priority directions.

4.2. Harmful factors intensity of which it is possible to reduce or compensate by preventive measures.

4.2.1. Natural climatic:

- deficiency of some vitamins in traditional kinds of food production;
- low content of mineral salts and microelements (iodine, fluorine, selenium, etc) in potable water (ultra fresh water);
- Deficiency of fresh vegetative products containing cellulose in the food structure of the population.

4.2.2. Anthropogenic:

- considerable accumulation of potentially hazardous wastes containing PCB, in the territory of settlements, in zones of industrial and defensive objects, and also along the coastline;
- absence of systems of monitoring, identification and neutralization of PCB sources;
- low level of organization and low efficiency of sanitary cleaning of the territory.

4.2.3. Factors changing susceptibility of an organism to the impact of harmful substances:

- functional overstrain of respiratory organs increasing an absorbed dose of foul gases and aerosols in respiratory ways;
- cold hypoxia reducing resistance of an organism to influence of some toxic substances;
- dehydration, worsening conditions of removal of harmful substances from an organism and their metabolites, and also reducing immune resistance of cutaneous covering and mucous membranes of respiratory ways.

4.2.4. Pathogenetic factors promoting accelerated development, heavy clinical course and failures of the diseases connected with influence of natural-climatic and anthropogenic risk factors:

- disorders of haemocirculation and arterial hypertensia;
- disorders of diffusing lung capacity;
- endocrinopathies;
- immunodeficiency disorders and cold allergy;
- keratopathy;
- disorders of carbohydrate and adipose metabolism.

One of the main strategic problems concerning sustainable development of Arctic regions, is stabilization of demographic processes, increase in duration of healthy life of the native population. Calculations of indicator DALY testify that this method can be quite adequately applied to the purposes of strategic planning, in particular for definition of volumes of the guaranteed medical aid to population of AZRF exposed to the risk of harmful influence of environmental pollution.

Use of the technique of D.C Rosenberg, P.A. Buescher (2002) is the most expedient. It is adapted to Russian conditions considering heavyness and consequences of diseases, average life expectancy, features of labour activity, environmental conditions and social and economic aspects of the people living in the Arctic zone of the Russian Federation. To calculate “years of life lost” all constant living adult population of able-bodied age from 18 to 60 years is singled

out. The technique allows to define reduction of life expectancy of people taking into account all revealed (registered) cases, on the basis of extracts from out-patient records (sheet of the exacted diagnosis) in a place of their residence. For calculation the data on medical aid appealability of the native population and also results of profound medical examination, as fullest and authentic source of information on about population health is used. Calculation is made in years of potential life lost; results are introduced in table 4.3 and table 4.4.

Table 4.3. Years of potential life lost of the native population living in the coastal area of the Russian Arctic regions from 2001-2009, connected with accumulation of acute and chronic diseases within the lifespan

Classes of diseases	2001		2003		2005		2007		2009	
	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life
Infectious diseases	4.7	0.8	5.4	1.0	6.2	1.1	8.1	1.4	8.2	1.4
Neoplasms	2.0	0.4	1.9	0.3	2.7	0.5	2.7	0.5	3.1	0.6
Blood and blood-forming tissues diseases	0.5	0.0	0.5	0.1	0.9	0.1	1.0	0.1	0.8	0.1
Endocrine system diseases	2.4	0.2	3.3	0.3	4.1	0.4	4.6	0.5	5.1	0.5
Mental disorders	7.3	0.8	6.7	0.7	7.0	0.8	8.8	1.0	9.4	1.0
Nervous system diseases	3.3	0.4	2.7	0.3	3.2	0.4	4.0	0.4	3.7	0.4
Eye diseases	3.4	0.3	4.8	0.5	6.2	0.6	10.6	1.0	13.0	1.3
Ear diseases	2.5	0.3	2.3	0.3	3.3	0.4	3.9	0.4	3.7	0.4
Circulatory system diseases	9.9	0.9	10.6	1.0	14.8	1.3	13.5	1.2	13.8	1.3
Respiratory diseases	28.3	2.5	30.8	2.7	38.4	3.4	40.6	3.6	31.4	2.8
Digestive apparatus diseases	8.1	0.8	7.8	0.8	11.4	1.2	13.6	1.4	13.0	1.3

Skin and hypodermic tissue diseases	5.1	0.5	5.6	0.5	8.3	0.8	10.3	1.0	8.7	0.8
Musculoskeletal system diseases	10.4	1.1	7.5	0.8	12.2	1.3	12.2	1.3	9.3	1.0
Urogenital system diseases	7.1	0.7	11.7	1.1	14.4	1.4	15.9	1.5	13.5	1.3
Complications in pregnancy and birth	2.8	0.3	2.0	0.2	1.5	0.1	1.4	0.1	3.7	0.4
Congenital anomalies	0.1	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0
Traumas and poisonings	7.7	2.2	8.3	2.4	14.8	4.2	17.9	5.1	14.1	4.0
Total years of "lost life"	12.3		13.0		18.0		20.8		18.6	

Table 4.4. Years of potential life lost of the native population living in the tundra area of the Russian Arctic regions from 2001-2009, connected with accumulation of acute and chronic diseases within the lifespan

Classes of diseases	2001		2003		2005		2007		2009	
	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life
Infectious diseases	4.7	0.8	5.4	0.9	6.2	1,1	7,9	1,4	8,1	1,4
Neoplasms	2.0	0.4	1.8	0.3	2.7	0,5	2,7	0,5	3,1	0,6
Blood and blood-forming tissues diseases	0.4	0.0	0.5	0.0	0.9	0,1	0,9	0,1	0,7	0,1
Endocrine system diseases	2.3	0.2	3.3	0.3	4.1	0,4	4,6	0,5	5,0	0,5
Mental disorders	7.2	0.8	6.6	0.7	6.9	0.8	8.7	1.0	9.0	1.0
Nervous system diseases	3.2	0.4	2.7	0.3	3.2	0.4	4.0	0.4	3.7	0.4
Eye diseases	3.4	0.3	4.6	0.5	6.1	0.6	10.4	1.0	12.3	1.2

Classes of diseases	2001		2003		2005		2007		2009	
	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life	Prevalence, %	Lost years of life
Ear diseases	2.5	0.3	2.3	0.3	3.3	0.4	3.9	0.4	3.7	0.4
Circulatory system diseases	9.9	0.9	10.6	1.0	14.7	1.3	13.3	1.2	13.3	1.2
Respiratory diseases	28.0	2.5	30.5	2.7	38.4	3.4	37.3	3.3	30.9	2.7
Digestive apparatus diseases	8.0	0.8	7.8	0.8	11.2	1.2	12.9	1.3	13.0	1.3
Skin and hypodermic tissue diseases	4.9	0.5	5.5	0.5	8.3	0.8	10.1	1.0	8.6	0.8
Musculoskeletal system diseases	10.3	1.1	7.5	0.8	12.1	1.3	12.2	1.3	9.3	1.0
Urogenital system diseases	7.1	0.7	11.5	1.1	14.3	1.4	15.5	1.5	13.0	1.2
Complications in pregnancy and birth	2.7	0.3	2.0	0.2	1.5	0.1	1.4	0.1	3.7	0.4
Congenital anomalies	0.1	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0
Traumas and poisonings	7.6	2.2	8.1	2.3	14.5	4.1	17.8	5.1	14.0	4.0
Total years of “lost life”	12.0		12.8		17.8		20.0		18.3	

On the basis of the calculations the total of years of lost life, owing to acute and chronic diseases of representative groups of the aboriginal population living in the Arctic zone of the Russian Federation is established.

Despite considerable efforts for improvement of availability and experienced level of medical aid, undertaken last years, especially in the investigated ChAO and NAO areas, the obtained data testifies to increase of years of " lost life” from 2001 to 2009, as for an aboriginal population living in a coastal area of the Russian Arctic regions, and for an aboriginal population living in a tundra zone. For a coastal area this indicator is a little bit higher and changed from 12.3 to 20.8 years, whereas for the population of a tundra zone – from 12 to 20 years. The greatest

contribution to the days of lost life is made by diseases of blood circulation system, respiratory organs, digestive organs, musculoskeletal system and connecting tissue, and also traumas and poisonings.

One of unsolved problems is increase of efficiency of measures on preservation and strengthening of health of the most vulnerable groups of the native population and, in particular elimination of the developed disproportion in the ratio of preventive and medical links of the health protection system. It is known that one of the major principles formulated both in the Russian national legislation, and in the documents accepted by the Arctic Council (AC) and the World Health Organization, is priority of prophylactic actions.

Concerning many classes of diseases this principle cannot be realized in full owing to a number of the objective reasons. There are very many stubborn questions in definition of the reasons and conditions of occurrence of some eurysynusic diseases of circulation organs, oncological, autoimmune and endocrinous diseases.

In cases concerning diseases reasons of which are rather well studied (for example, many infectious, industrial and ecologically caused diseases, traumas, poisonings and their consequences, etc.), possibilities of preventive medicine in their control and management are much more powerful. However, unfortunately, in these cases the accumulated scientific and practical potential is not always demanded

Application of scientifically substantiated and adequate measures of prevention among women planning pregnancy and children from among the native population of Arctic regions experiencing influence not only of adverse natural-climatic factors, having intensive and long character in the Arctic areas, but also essential influence of anthropogenic pollutions of environing natural habitat by persistent toxic substances (PTS) is especially important. Comprehension of importance of solving of a problem of preservation and improvement of population health in these areas demands development of adequate methods of its estimation and forecasting, introduction of modern medical technologies considering specific features of occurrence, distribution, a clinical course and results of diseases among

the population living in the Arctic and subarctic areas. Existing methods of prevention and treatment of diseases in specific conditions of Arctic regions, and also connected with environmental pollution, do not meet in full modern requirements to which testify, in particular, one of the highest in Europe indicators of infantile mortality, especially among the native people of the Russian part of Arctic regions (to 60 events per 1000 children, born alive) and unsatisfactory dynamics of indicators of general morbidity and mortality of the population, and also indicators of average duration of forthcoming life (50 years among men and 61 – among women).

Main polluters of inhabitancy with persistent toxic substances in the remote regions of the Far North are perennial accumulations of un utilized transport and industrial wastes formed in the result of mass delivery of means, fuel and other industrial goods intended for maintenance of economic activities and satisfaction of household needs of the population of these areas, (so-called "northern delivery"). The essential role in formation of risk of damage effect is played also by the intensive pollution with PTS of premises formed, mainly, in the result of uncontrollable use of various kinds of chemical protection means against insects and rodents, some kinds of paints, and also at manufacturing of lead ammunition for hunting and fisheries in home conditions. Pollution of inhabitancy owing to global transfer of PTS to the Arctic areas of Russia brings much smaller contribution to an exposition, averaging from 5 to 20 % of the general receipt of these substances in an organism of aboriginals. However in the conditions of intensive melting of permafrost soils and sea Arctic ices under the influence of known climate fluctuations, preconditions for illuviation directly in inhabitancy of group of high-toxic reproductive toxicants from their burial places and warehouses, including lead, mercury, chlororganic persistent pesticides and lubricators were created. The estimate of risks of reproductive health disorders and their prevention is one of the main problems of maintenance of stable demographic development of native smaller peoples of AZRF that has found its reflexion as a priority in the documents accepted by the Arctic Council (Salekhard Declaration of 2006), and in

the decision of Security council of the Russian Federation “About foundations of public policy in Arctic regions”.

5. Recommendations for application of methods of neutralization of residential and public buildings, soils, water and food from PTS and decreasing their damage effect.

5. 1. Sanitary-and-epidemiologic measures to prevent spread of persistent toxic substances

Actions for planning and realization of measures for prevention of the adverse consequences connected with climate fluctuation should contain additional sanitary-and-epidemiologic requirements to economic activities regulation. Complex of these actions should provide:

- primary use of waste-free and low-waste technologies for transport and industrial objects;
- limitation of construction and exploitation of the objects, activity of which is connected with formation of hard utilized waste;
- creation of systems of rational and ecologically safe water consumption;
- creation of effective recycling systems for hazardous wastes, including containing PTS, and limitation of application of those ways of their neutralization which are based mainly on the use of natural self-cleaning potential of a natural habitat;
- sanitary arrangement of industrial and transport waste storages created earlier;
- organization of effective control over safe use of chemical means for protection of premises, animals and plants against insects and rodents in the home and in industrial activity;
- replacement of materials containing lead, including ammunition for hunting and fishing, to harmless metal and plastic compositions;
- development of detoxification ways for building designs in residential and industrial premises polluted with PTS;

- development of ways of soil neutralization and disinfecting in the territory of settlements and farmlands.

5.2. Measures for prevention of soil pollution with PTS in the territory of settlements in the Arctic areas

Climate fluctuations in Arctic regions can affect increase of risk of especially hazardous infections not only for the account of expansion of an areal of carriers of infectious activators, improvement of conditions of their wintering ground, but due to increase of winter temperatures and thickness of a snow cover. Severe hazard can introduce return to ecosystems of activators of especially hazardous infections of XVIII-XIX centuries owing to defrosting of permafrost soils in burial places of people who died of them and paleomicroorganisms because of defrosting of remains of mammoth fauna in the layer of permafrost soils. Contamination hazard for soils is defined by the level of its possible adverse influence on inhabitancy: water, air, foodstuff, and also direct or indirect influence on a person, biological activity of soil and self-cleaning processes. In this connection prevention of adverse consequences should include:

1. Estimation of sanitary-ecological hazard of soils for health and conditions of residing of the native population is recommended to be performed by the results of their laboratory research in the territory of settlements, including definition of PTS content.
2. Laboratory researches of sanitary-ecological hazard of soils first of all should be made in the territory of a residential construction of settlements, in a zone of sanitary protection of reservoirs, and also in the territory occupied by nurseries and medical institutions, etc.
3. If there are harmful substances in the ground of human settlements, exceeding recommended limiting levels and standards, it is necessary to develop special actions for recultivation and neutralization of soils and protection of water-producing territories, and also for disease prevention among population, occurrence, spread and course of which can be connected with specific soil pollution (table 5.1 and 5.2).

4. It is recommended to organize regular monitoring of levels of soil pollution with harmful substances, and also of efficiency of measures for its neutralization and restoration.

Table 5.1 Maximum allowable concentrations of PTS and limiting indexes of soil pollution

Substance	MAC value, mg/kg of the soil considering background (clarke)	Limiting index
Benzapyrene	0.02	General sanitary
□- HXB (lindane)	0.1	Translocation
HXB (hexachloran)	0.1	Translocation
HXB (hexachlor- butadiene)	0.5	Translocation
Heptachlor	0.05	Translocation
DDT and its metabolites (general number)5	0.1	Translocation
Mercury	2.1	Translocation
Lead	32.0	General sanitary

6. Estimation of hazard of chemical pollution of soils as an indicator of adverse effect on health of the native population can be made by total index of PTS pollution **(Z_c)** (Table 5.2).

Table 5.2. Rough rating scale of contamination hazard of soils by total index of PTS pollution

Category of soil contamination	Value Z_c	Expected health disorders among the population living in the polluted territory
Allowable	Less than 16	Deviations in indicators of population health in connection with soil pollution are not observed
Medium hazardous	16–32	Increase in indicators of prevalence of chronic diseases among the population by 15-30 % is possible
Hazardous	32–128	Increase in indicators of prevalence of chronic diseases among the population to 2 times and increase in risk of reproductive disorders to 2 times is possible.
Extremely hazardous	More than 128	More than 2 times increase in indicators of prevalence of chronic diseases and disorders of a reproductive health of population is possible.

* - The indicator of total pollution for PTS is defined as a sum of ratios of concentration of each substance to its maximum concentration limit in soil.

5.3. Collection, neutralization, transportation, storage of potentially dangerous waste containing PTS.

1. Measures for prevention of PTS damage effect on the native population should provide first of all organization of regular clearing of waste of the territory of settlements in areas of traditional residing of the native population according to ecological, sanitary-and-epidemiologic and other requirements.
2. It is necessary to provide creation of objects of waste disposal on the basis of permissions issued by special authorized federal bodies by the results of special geological, hydrological and sanitary-chemical researches, and also on the basis of consultations of local self-government institutions and lawful representative organizations of the native people.
3. In territories of waste disposal and within their influence on environing natural habitat proprietors of waste disposal objects are obliged to carry out monitoring of the environmental condition when due hereunder, and also to organize and carry out industrial control of observance of the legislation of the Russian Federation in the field of waste treatment.
4. It is recommended to forbid burial of waste, containing PTS, in the territory of settlements of native population, and also within water security zones, in the water-producing areas of underground water objects which are used with a view of drinking and economic-household water supply, in places where fractured ground exits to the surface; in places of waterbearing formations checkout, and also closer than 500 m from the territory of nurseries and medical institutions.
5. Hazardous waste depending on the degree of their damage effect on the environment and people's health is subdivided into hazard classes according to the criteria introduced in Table 5.3.

Table 5.3. Classes of hazard for waste containing PTS

Hazardous class	Chemical substance
1	Arsenic, cadmium, mercury, lead, selenium, zinc, fluorine, benz (a) pyrene, organochlorine pesticides, polychlorinated biphenyls.
2	Boron, cobalt, nickel, molybdenum, copper, antimony, chrome.
3	Barium, vanadium, tungsten, manganese, strontium

6. Landfills of solid domestic waste (SDW) are special constructions intended for isolation and neutralization of SDW, and should guarantee sanitary-and-epidemiologic safety of the native population. Landfills can be organized for any human settlements. However in many countries conversion from landfill type of hazardous waste storage to closed forms of burial in specially equipped storehouses gains increasing distribution.
7. Burial and neutralization of hard, pastelike and liquid industrial and transport waste containing PTS, should be made in special landfills provided with effective protection against penetration of pollutants to the environment. An organization responsible for exploitation of the landfill should develop the regulations and a regime of its work, instruction for waste receiving, to provide control of their composition, to keep account of the arriving waste and to provide performance of requirements of production schedules for isolation and recycling.

5.4. Actions for prevention of contamination of dwellings with dangerous chemical substances

1. During creation of new chemical means intended for household application, and also ways of their packing, storage, transportation, sell and recycling, requirements providing sanitary-and-epidemiologic public safety should be developed.
2. All chemical products and means intended for use in the household purposes should not contain PTS, contact with which is interfaced to uncontrollable risk of damage effect on an organism.

3. If in the course of storage or use materials and products can get new or lose their main properties therefore there is a risk for health of a person, useful life limitations are established for such products.
4. Indicators of sanitary-and-epidemiologic safety of new chemical means for household application, shelf lives, requirements to packing, marking, transportation, storage, recycling, processes of their manufacturing, test methods, ways of recycling or destruction should be included to special technical regulations.
5. Chemical means for household application should be packed in a way to provide sanitary-and-epidemiologic safety. Except the information defined by the consumer protection legislation of the Russian Federation, additional information in Russian, containing the following data should be specified on labels or inserts of the packed products:

- purpose, conditions of storage and application of a product and potential risk for health disorder if rules of its application are braked;
- Precautions and first aid at occurrence of signs of health disorders, connected with damage effect of a product on an organism;
- ways of disposal and neutralizations;
- Manufacturing date and packing date of a product.

6. If during storage and transportations of chemical means for household application there was a breach leading to acquisition by them of hazardous properties, individual businessmen and legal bodies carrying out storage and transportation are obliged to inform owners and recipients of products.
7. In retail trade sale of unpackaged chemical means, and also means which have not been provided with the necessary information is not allowed (see item 5.).
8. Chemical means for household application of which can be connected with risk for population health are subject to obligatory registration and certification according to the legislation of the Russian Federation.
9. If inner surfaces of residential and public buildings, and also subjects of use, equipment and contact surfaces in working zones are polluted with PTS, their

neutralization should be made according to recommendations, approved by the bodies of public health control.

5.5. Protection of water objects, potable water and drinking water supply.

Access to safe water remains an extremely important question of population health as in many human settlements infectious agents are still found in potable water. Especially population with low per capita income suffers from a lack of qualitative water. In the Arctic region according to Rospotrebnadzor [About sanitary-and-epidemiologic situation in the Russian Federation in 2008, 2009] the most unsuccessful situation with water quality of drinking water supply has developed in the Republic of Sakha (Yakutia) where 32 % of the analyzed samples of water from reservoirs of the 1st category do not correspond to hygienic specifications by microbiological indicators which is 1.3 times higher than the average index in the country. In recent years the condition of water objects in the Republic of Sakha (Yakutia) worsens which is connected both with proceeding anthropogenic pollution, and with annual natural cataclysms in the form of spring floods at opening of the rivers and autumn flooding (Protodyakonov, 2007). Results of special sanitary-virologic research testify to a wide spread of pathogenic viruses in the river Lena– the main source of drinking water supply for settlements of this republic (Ecological and epidemiological estimation of the river Lena water quality, 2006).

Poor water quality of surface water sources by sanitary-chemical indicators in water intake points also is characteristic for Arkhangelsk region (in 2005-2006 75-77 % of the investigated samples), in Khanty-Mansiysk autonomous okrug (50 %), Yamal-Nenets autonomous okrug (53-61 %), the Republic of Sakha (Yakutia) - 29-42 %, Magadan region (28 %) and by microbiological indicators in Arkhangelsk region - 36-49 % of water samples, in Yamal-Nenets autonomous okrug - 37-33 %. Among all Russian entities the Republic of Sakha (Yakutia) differs in substantial growth of number of water samples which do not correspond to hygienic specifications by microbiological indicators. Even after corresponding water processing, including its disinfection, in the water supply network of

Arkhangelsk region the share of water samples which do not correspond to hygienic specifications by microbiological indicators is rather great. None of the territories of Arctic regions was included into the list of regions with high quality of potable water. Deficiency of drinking water is experiences by the population of Chukchi autonomous okrug, in Koryak autonomous okrug - to 10 % and in Evenki autonomous okrug – to 60 % of inhabitants use water without clearing and disinfecting from wells and rivers, there are no sewer constructions on all extent of the river Ob in the territory Yamal-Nenets autonomous okrug. Special regional programs for provision of the population with good-quality potable water are developed only in Murmansk area, Chukchi and Jamalo-Nenets autonomous okrugs [About sanitary-and-epidemiologic situation in the Russian Federation in 2006, 2007].

Climate warming can cause further deterioration of potable water in the Arctic region. During destruction of permafrost territory on which Norilsk, Yakutsk, Anadyr and many other cities and settlements are constructed, there are possible failures on water-sewer systems which can promote outbreaks of intestinal infectious diseases. In this connection prevention of adverse consequences should include:

1. Water objects used with a view of drinking and economic-household water supply should not be sources of biological, chemical and physical factors of damage effect on a human.
2. Use of water object for provision of any economic-drinking needs of the population is supposed only in the presence of sanitary-and-epidemiologic conclusion about its conformity to sanitary-and-epidemiologic safety requirements.
3. Criteria of safety (harmlessness) of water objects for a human, including maximum permissible concentration of persistent toxic substances in water, are established according to hygienic norms (Table 5. 4).
4. Maximum permissible discharge is established for each discharge of sewage and each pollutant, proceeding from a condition that its concentration will not exceed standard requirements in the water of a water object closer than 500 m from the discharge place.

5. All kinds of production applied in practice of drinking and hot water supply, are subject to obligatory sanitary-and-epidemiologic estimation of its safety for a human, including:

- . reagents, added to water;
- . equipment and constructional materials (pipes, capacities for water storage and transportation) and means used for processing of their inner surface;
- . filtering and conditioning materials (filters, ion-exchange resins, membranes, sorbents);

Table 5.4. PTS, normalized in potable water by a sanitary-toxicological feature

Indicators	Units of measure	Standards (max.)	Hazardous class
Hexachlorobenzene	Mg/l	0.001	1
Cadmium	Mg/l	0.001	2
Polychlorinated biphenyls	Mg/l	0.001	1
Mercury	Mg/l	0.0005	1
Lead	Mg/l	0.01	2
2,3,7,8-Tetrachlor-dibenzodioxin	Mg/l	20	1
Benzapyrene	Mkg/l	0.01	1

5.6. PTS monitoring in traditional foodstuff

1. Safety requirements to the permissible level of content of toxic substances should be applied to all kinds of food raw materials and foodstuff, including those which are traditional kinds of a trade for native people.
2. Priority regulated indicators for provision of sanitary-and-epidemiologic safety of traditional foodstuff are:

- Mercury (general and methylated)
- Cadmium
- Lead
- Organochlorine pesticides
- Polychlorinated biphenyls

Contamination of the products intended for baby food with benz (a) pyrene detected by modern methods is not allowed.

3. In all kinds of food raw materials and foodstuff it is recommended to carry out systematic inspection of the content of regulated persistent toxic substances in the order provided by the legislation of the Russian Federation.

4. Sanitary-and-epidemiologic examination of food raw materials and foodstuff should be carried out on the basis of operating hygienic specifications with obligatory definition of the content of pesticides, in particular isomers of hexachlorcyclohexane, DDT and it metabolytes.

-. Polychlorinated biphenyls are monitored in fish, meat and grease of sea animals and sea and fish products; 3,4-benz (a) pyrene - in grain, in smoked meat and fish products.

-. Mercury, cadmium and lead are defined in fish, and also in meat of animals and their internals, besides, definition is made separately in kidneys of animals.

5. For the main products of traditional nutrition of native population it is recommended to carry out periodic (at least 2 times a year) monitoring of other high-toxic substances limiting content in foodstuff and food raw materials of which is regulated by the legislation of the Russian Federation.

6. Recommendations for application of measures of preventive health care and premature mortality connected with PTS

Analysis of morbidity and premature mortality of the native population shows that implementation of the main priority of the state policy in Arctic regions which is public health care of Arctic regions can recognize the following directions:

1. Decrease in the risks connected with excessive accumulation in the Arctic ecosystems and, in particular, in traditional foodstuff of persistent toxic substances (PTS), many of which are made and applied far outside of Arctic regions.

2. Struggle with infectious diseases

3. Decrease of risks connected with local pollution with radioactive nuclides;

4. Growth of the indicator of provision of the population with guaranteed kinds and volumes of medical aid taking into account the main features of occurrence, a

clinical course and results of diseases, the most widespread among the population living in the Arctic areas with raised levels of pollution of objects of environment;
5. Improvement of effective availability of qualified medical aid and degree of involvement of the native population in programs of prevention and treatment of the most widespread diseases, including introduction and development of telemedical technologies.
5. It is necessary to admit that the most effective measures of disease prevention in severe ecological-environmental conditions of industrial centers of the Far North are reasonable limitation of duration of employment of workers in trades with harmful working conditions, obligatory application of examinations of professional suitability of workers to perform work in the Arctic zone and observance of scientifically substantiated specifications of sanitary-and-hygienic working conditions.

Therefore in the specified regions besides introduction and realization of effective methods of secondary prevention and rehabilitation of general and professionally caused diseases, scientifically substantiated system of professional medical selection and measures of primary prevention is also necessary.
One of unsolved problems is increase of efficiency of measures on preservation and strengthening of health of the most vulnerable groups of the native population and, in particular elimination of the developed disproportion in the ratio of preventive and medical links of the health protection system. It is known that one of the major principles formulated both in the Russian national legislation, and in the documents accepted by the Arctic Council (AC) and the World Health Organization, is priority of prophylactic actions.

Concerning many classes of diseases this principle cannot be realized in full owing to a number of the objective reasons. There are very many stubborn questions in definition of the reasons and conditions of occurrence of some eurysynusic diseases of circulation organs, oncological, autoimmune and endocrinous diseases.

In cases concerning diseases reasons of which are rather well studied (for example, many infectious, industrial and ecologically caused diseases, traumas, poisonings and their consequences, etc.), possibilities of preventive medicine in their control and management are much more powerful. However, unfortunately, in these events the saved up scientific and practical potential is not always demanded.

Principle approach to improvement of planning of similar actions consists in application of cohort type of researches for definition of efficiency of the actions performed earlier. In the pilot project such estimation of efficiency has been used concerning the measures directed to decrease of influence of persistent contaminants on an organism of representatives of the studied cohort of adult population who took part for the first time in the first examination in 2001. As a result the complex of the international-approved recommendations has been executed selectively in a number of villages with a primary native population. General idea about changes of damage effect on a human body of priority pollutants, as a result of practical realization of these recommendations, will be estimated by measurement of their actual concentration in blood in comparison with the results measured in 2001. Identical reports of polls and estimation of ways of influence of harmful contaminants, food ration, traditional kinds of activity and other social and behavioral risk factors will be applied within the limits of the offered project. It is extremely important, that the same individuals participated in repetitive examinations with a view of minimizing of the errors connected with individual variations.

It is supposed that such comparison of biomarkers of the exposition, documented for two groups of native settlements (those who participate and do not participate in realization of recommendations), will allow to estimate both cumulative effect from realization of rehabilitation measures, and the possible consequences connected with others non-chemical risks, in particular climate fluctuations, social and economic conditions of the population living in native communities of AZRF.

The essence of the approach to the analysis of economic efficiency of measures on decrease of influence on health consists in concept DALY (the expected years of life corrected to physical inability) and QALY (expected years of the life, corrected to quality of life), both allow to calculate years of "healthy life", lost as a result of influences of the specific reason or disease, in the specified area. The fullest this indicator of damage effect on health will be estimated, the more precisely social and economic efficiency of various actions and projects will be specified.

This methodology was developed and recommended by World Health Organization as a part of the program "Diseases Burden" and widely used both in health care sector, and by regulating bodies as a basis for decision-making on investments into disease prevention and environment pollution control. This approach is widely used for estimation of economic consequences of air pollution (for example, the World Bank) though its application concerning water and soil pollution is more complicated. Calculation of DALY indicator is carried out by a World Health Organization technique. It is supposed that after carrying out of rehabilitation actions in the territory, this indicator is most sensitive to changes of conditions and intensity of damage effect on the population.

Application of scientifically substantiated and adequate measures of prevention among women planning pregnancy and children from among the native population of Arctic regions experiencing influence not only of adverse natural-climatic factors, having intensive and long character in the Arctic areas, but also essential influence of anthropogenic pollutions of environing natural habitat by persistent toxic substances (PTS) is especially important. Comprehension of importance of solving of a problem of preservation and improvement of population health in these areas demands development of adequate methods of its estimation and forecasting, introduction of modern medical technologies considering specific features of occurrence, distribution, a clinical course and results of diseases among the population living in the Arctic and subarctic areas. Existing methods of prevention and treatment of diseases in specific conditions of Arctic regions, and

also connected with environmental pollution, do not meet in full modern requirements to which testify, in particular, one of the highest in Europe indicators of infantile mortality, especially among the native people of the Russian part of Arctic regions (to 60 events per 1000 children, born alive) and unsatisfactory dynamics of indicators of general morbidity and mortality of the population, and also indicators of average duration of forthcoming life (50 years among men and 61 – among women).

7. Conclusions

Thus, in the result of performance of the pilot project new scientific data is obtained, allowing to estimate the changes which have occurred since 2001 in intensity of damage effect of resistant pollution on an organism of inhabitants of Chukchi AO and to develop a complex of additional recommendations for application of methods of improving and rehabilitation actions adapted to conditions of the polluted Arctic settlements.

1. Methods of medical-ecological examination of 30 men and 30 women under the report, similar to those applied for these people in 2001, showed that in an observable cohort of the natives of Chukchi rayon the content in an organism of the overwhelming majority persistent toxicants, arriving to Arctic regions in the result of global (distant) transfer, has statistically essential tendency to decrease.

2. At the same time, in blood the content of the pollutants arriving in inhabitancy mainly from local sources, first of all PCB and lead, for a male part of the population has shown essential increase for this period, despite realization of some recommendations for decrease of risk of PTS damage effect, developed by the international commission of AMAP experts.

3. Special training seminars executed in 2003-2006 among ChAO natives have not essentially raised level of their awareness of risk factors of PTS damage effect and measures on its prevention.

4. Indicators of general mortality of CHAO population, and especially cumulative trend of indicators of disease frequency, associated with PCB damage effect on an organism, have essentially increased, especially for the last 3 years. Thus the trend of disease frequency potentially have not been connected with an adverse effect of mentioned group of chlororganic compounds, has not changed essentially.

5. Weak positive link between an average index of progress of pupils of elementary school and PCB level in an umbilical blood at their birth is revealed. Degree of this link has appeared higher in a cohort of children living in those settlements where recommended actions for decrease of PTS damage effect were not made.

6. Though within the limits of the executed pilot project the problem of establishment of the reasons of observable changes in intensity of PTS damage effect on the native population was not put, however insufficient efficiency of actions for rehabilitation of the territories polluted with PTS, may be caused by accelerated "re-opening" of landfills of hazardous waste as a result of melting of permafrost soils and increase in their receipt in inhabitancy in connection with observable climate fluctuations. The found out tendency of increasing of PCB specific content on an inner surface of building designs of dwellings in settlements of the natives can indirectly testify to it.

7. During performance of the pilot project priority external factors f health loss risk among AZRF population are also defined, estimation of the contribution of separate kinds of diseases to formation of unsatisfactory dynamics of demographic processes and quality of life is given, some

questions connected with possible reasons of insufficient efficiency of recommendations developed by the international commission of AMAP experts realized during period 2003 - 2009 are considered,.

8. On the basis of the received data about insufficient efficiency of the realized programs additional recommendations about application of advanced methods of estimation of social and economic efficiency and planning of the actions directed to protection of AZFR population from damage effect of pollutants, to provision of sanitary-and-epidemiologic public safety, including improvement of measures of medical prevention of health disorders connected with influence of resistant pollution of inhabitancy are developed.

9. Extremely low estimation of overall performance of population training testify to necessity of radical change of the methods of such work which should have system (constant) character and be organized beginning with children's collectives (kindergartens, schools).

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