

Ecological Assessment of Population Health Indicators in the Republic of Karakalpakstan and Their Relationship with the Environment

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Abstract. *The article presents the study results, the ecological assessment of population health indicators of the Republic of Karakalpakstan and their relationship with the environment. The structure analysis of the nosological disease forms distribution showed that there is some redistribution of the main nosologies. The environment acts as a whole, and the whole influence is always greater than the sum effect of the individual parts.*

Keywords: *Karakalpakstan, health state, environment, monitoring, nosologies, correlation models.*

Relevance.

Currently, the problem of improving the environment state, preserving natural resources are priority and urgent. Human activity is acquiring the global processes scale, which has led to the dangerous regions, separate zones creation with a tense environmental situation, human health deterioration, causing significant damage to nature [1, 4].

The environmental factors impact result of various nature (chemical, physical, biological) and character (social, economic, natural and climatic) is an increase in mortality, morbidity, deterioration in physical development and an increase in the number of people with pre-pathological conditions [2,12]. Numerous studies, the population health state in connection with the various factors influence, which were carried out in our country and abroad, have convincingly proved that environment pollution and living conditions adversely affects the population health [4].

Health as the main indicator reflecting the humanity ability to most effectively carry out its social and biological function in certain conditions of a particular region is widely used in scientific research [12]. The study of environmental factors influence on the structure, health indicators level and dynamics makes it possible to identify "ecologically conditioned" deviations of these indicators and to carry out zoning of territories according to the environmental comfort degree [6]. Therefore, in order to develop rational tactical decisions aimed at improving health and reducing morbidity and mortality in the Republic of Karakalpakstan, it is necessary to study in detail the factors that determine and shape health in modern conditions, and ways to prevent them.

Material and methods.

All 15 districts of the Republic of Karakalpakstan were selected as research objects. When performing the work, a complex of modern socio-ecological, physical-chemical, hygienic, statistical research methods were used.

The archival data of Karakalpak departments "Suuakaba", "Karakalpaktutyunyu", statistical data of the Ministry of health of the Republic of Uzbekistan, medical documents of the organizational methodology department of the Republican clinical hospital №1, Central district hospitals of the Ministry of health, the Ministry of macroeconomics and statistics of the Republic of Karakalpakstan were used.

The air quality was studied on the basis of the data provided by the Glavhydrometeocenter of the Republic of Karakalpakstan. The annual territorial loads calculation of pesticides by districts was carried out according to the Methodological recommendation "Study of the pesticides effects and plant growth regulators on the population health " (1985), as well as archival data of the Karakalpak branch of "Uzselkhozkhimiya". The pesticides presence in soil, water and food was determined by thin layer chromatography method. Analyzes were carried out in the ecology department of Karakalpak scientific research institute of experimental and clinical medicine of the

ministry of health of the Republic of Uzbekistan. Hydrochemical analysis of water was carried out in the ecology laboratory of microorganisms and the hydrochemistry laboratory of the Karakalpak scientific research institute of natural sciences of the KCO AS RUz according to the generally accepted method described by N.S. Stroganov, N.S. Buzinova (1980), Yu. Yu. Lurie (1984), Yu.V. Novikova and others. (1990), Methodical guidelines for ecological and hygienic zoning of the Republic of Uzbekistan territory according to the danger degree to public health [16].

The discussion of the results.

The population health always occupies one of the first places in the life values system of any state. Preserving public health and reducing morbidity, the most important socio-economic tasks facing the state and health care, in solving which the experience of many sciences is used: ecology, medicine, demography, hygiene. [1, 4, 6].

Among the main environmental factors that form the incidence of the population were attributed: air quality, specific gravity of non-standard drinking water samples according to sanitary-chemical indicators, specific gravity of non-standard drinking water samples according to microbiological indicators, coefficient of soil pollution with heavy metals, application of mineral fertilizers, pesticide load, soil degradation, etc. [4, 6, 13].

Large-scale measures to prevent the impact of unfavorable factors on public health and the environment can be expressed in the effective use of territorial differentiation with varying degrees of environmental stress and contamination of the surveyed territories [12, 14]. For this purpose, at the initial stages of the introduction of these developments in the practice of ranking the territory, it is necessary to collect and evaluate actual data on regional parameters of the environment and the state of health of the population [1, 6].

The transformations of the Aral Sea ecosystem, occurring as a result of a sharp change in the water regime, are numerous and varied. Under the conditions of the development of anthropogenic desertification processes, salts are removed from the drained bottom of the Aral Sea, degradation of the vegetation cover is observed, and the intensity of salt accumulation processes in the soil increases [13]. On the drained bottom, new, shallow groundwater horizons are formed, with a high capillary rise in moisture and salinity from 20 to 100 g/l. After the second year of draining the bottom of the Aral Sea, the coastal areas turn into plump salt marshes, the dryness and flowability of the soil increases. The carrying out of salts to the adjacent irrigated lands, which occurs at the same time, causes a significant decrease in the productivity of agricultural crops [5, 13].

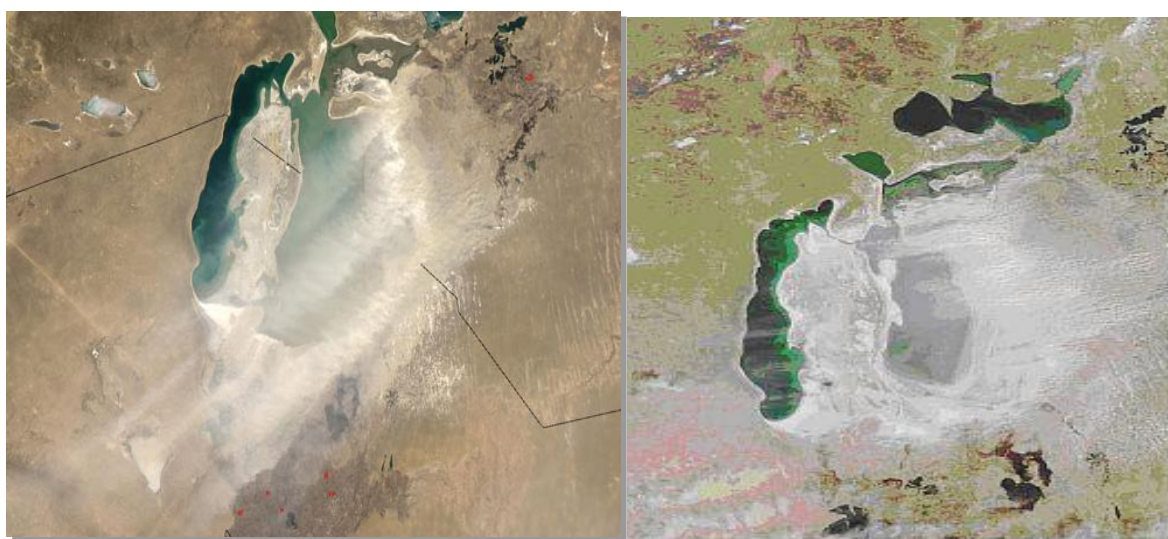


Figure: 1. Wind removal of salts on March 15, 2002 and April 10, 2008 - synthesized (1-3 channels) image from the NOAA satellite.

The impact of salt aerosol from the post-aquatic land on the ecological situation in the southern Aral Sea region is not limited to soil salinization and vegetation degradation [2, 15]. It is

known that an increase in the concentration of aerosol in the air affects the kinetics and dynamics of atmospheric processes. Observational data show that cloud condensation cores consist, as a rule, of sulfates, which are the prevailing fraction in the mineral components of aerosol carried by the wind from the dried Aral Sea bottom [13, 15]. It should be noted that satellite images are highly informative when used in the operational work of specialized services and scientific research for the diagnosis of salt removal.

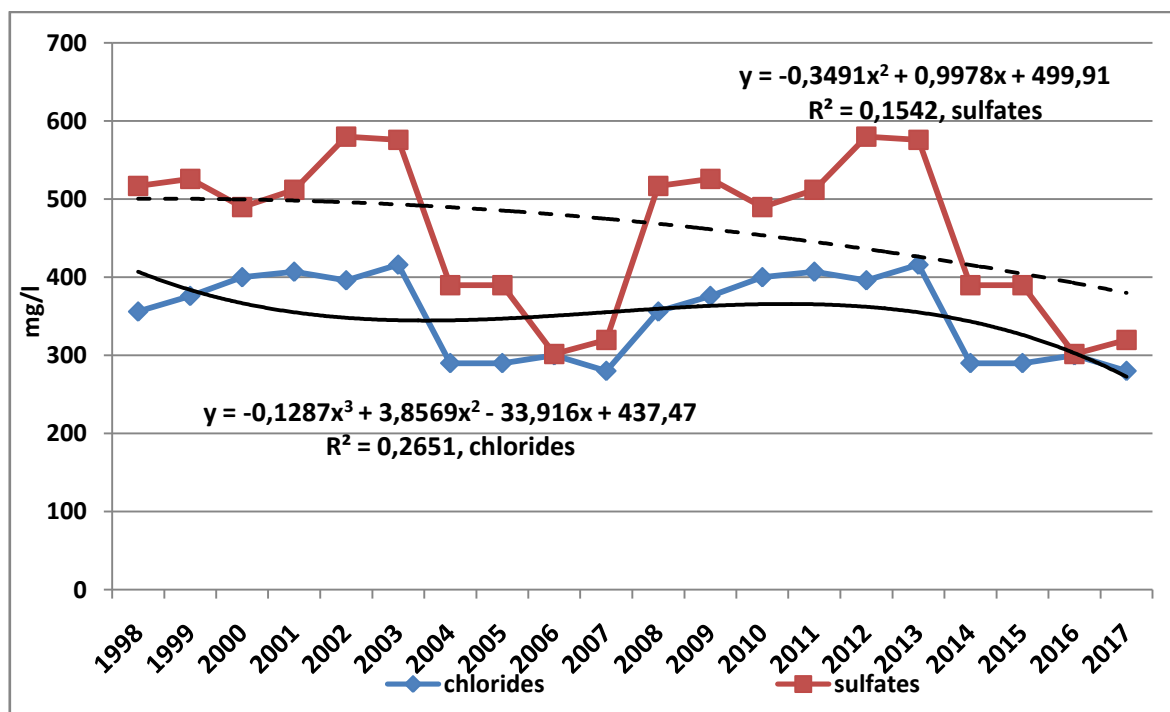


Figure: 2. Dynamics of the content of sulfates and chlorides in drinking water of the Republic of Karakalpakstan

It is also well known that the water factor plays a dominant role in the functional activity of all living organisms and occupies one of the most important and significant places in any environmental research, as the main factor that determines the way of life, the conduct of economic activities of people [5, 9].

The main content of substances such as chlorides and sulfates is one of the prevailing ones in the general pollution of water resources in the Republic of Karakalpakstan.[9]. In the presented dynamics of the chloride content in water, it can be observed that over the considered period of time, there is a cyclical nature (Fig. 2). The lowest rates were recorded in the period from 2004 to 2007. The polynomial trend is directed towards a decrease in this indicator. As for the content of sulfates in water, there is also a cyclical nature of the dynamics. The lowest values can be seen in the period from 2004 to 2008, as well as from 2014 to 2017 and at present. The established polynomial trend is directed downward.

The conducted studies show that the highest level of mineralization in water sources of drinking water supply is recorded in the Muinak, Karauzyak, Takhtakupyr, Kanlykul, Khodjeili and Amu Darya regions. Also, in all areas there is a rather increased degree of water hardness. A higher degree of total water hardness is found in the Munayk, Karauzyak, Takhtakupyr, Shumanai, Kanlykul, Khodjeili and Beruni regions of the Republic of Karakalpakstan [9, 14]. As for the presence of trace elements exceeding the TLV, Table 1 shows that the absence of such trace elements was noted only in the Chimbay region, the maximum amount is recorded mainly in the northern regions - Shumanai, Kungrad, Muynak regions. [5].

Table 1.
Criteria for assessing water pollution used in the system
Glavgidromet of the Republic of Uzbekistan

Qualityclass	Pollutiondegree	The value of the water pollution index (WPI)
1	Veryclean	Less than or equal to 0,3
2	clean	Morethan 0.3 to 1
3	Moderatelypolluted	Morethan 1 to 2
4	Contaminated	Morethan 2 to 4
5	Dirty	Morethan 4 to 6
6	Verydirty	Morethan 6 to 10
7	Extremelycontaminated	Morethan 10

The differential ranking analysis of the contaminated regions territories of the Republic of Karakalpakstan precisely by the density of the water factor pollution allowed us to distinguish 4 ecological water pollution groups, depending on the regional differentiation: 1st group – WPI - 1,3 (Nukus city, Chimbay region); 2nd group – WPI 2,8 -3,5 (Khojeyli, Nukus, Kegeyli regions); 3rd group– WPI 4,7-5,8 (Takhtakupyr, Karauzyak, Kanlykul, Amu Darya, Turtkul districts); 4th group– WPI 6,7-9,4 (Kungradsky, Muynaksky, Shumanaysky, Beruni districts).

In the Southern Aral Sea area, soil salinization (mainly sulfate and chloride) is a widespread and progressive process. So, in 1975, 43% of irrigated lands were salinized, in 1985 - 80%, in 1997 - 94%. Since 1960, takyrs and saline soils have increased by 91 thousand hectares, salt marshes and sands - by 43 thousand hectares. The soils of the lower reaches of the Amu Darya accumulate more than 1 million tons of salts annually [8]. The formation of saline soils is associated with the accumulation of salts in groundwater and rocks and conditions conducive to their accumulation in soils. One of the sources of salts in soils is mineralized groundwater at a shallow level. In the Republic of Karakalpakstan in 1980-1989, 4.8 thousand tons of pesticides were used, including persistent and highly toxic ones. Density of application is 13.2 kg/ha. In spring, the amount of hexachlorocyclohexane (HCH) in soils in some cases reached 3-5 TLV [8, 11].

It is well known that the indicators of public health in relation to the state of the environment, recommended by the WHO Regional Office for Europe in the framework of the "Health for All" strategy, include respiratory diseases [1, 16]. Respiratory diseases occupy one of the leading places in the structure of morbidity in the population of the Southern Aral Sea region: their contribution to the morbidity of the entire population is 38.9%, of the child population - 46.4% [6]. As you know, the respiratory system is "borderline", that is, it is in direct contact with the external environment and is one of the first to respond to changes in external conditions - dustiness of the surface air layer, chemical pressure on the body from drinking water and food, which weakens adaptive capabilities person [3,4].

According to Kazakh scientists [10], a comprehensive examination of the respiratory organs in children from the Aral Sea region made it possible to identify new diseases, with the peculiarities of the course of chronic diseases of the upper and lower respiratory tract, and also for the first time to diagnose interstitial lung injuries, leading to profound functional and cytomorphological changes in lung tissue, which is a consequence of an unfavorable situation and pollution of the air basin with dust-salt particles [10].

One of the reasons that caused a high increase in the incidence of the population in recent years may be the high level of air pollution in Karakalpakstan. The system for monitoring the quality of atmospheric air and drinking water in the Southern Aral Sea region does not sufficiently meet the modern requirements for assessing the risk to public health, since it does not allow determining the level of pollution impact on the human body [5, 9]. Analysis of long-term factual data on the incidence of respiratory organs among the population of Karakalpakstan shows (Fig. 3) that the incidence of respiratory organs among the population of three zones (northern, central and southern) peaked in 2013, 2014, and in subsequent years somewhat stabilized at a high level.

Among the districts of the Republic of Karakalpakstan, a high incidence rate was observed in the Amudarya, Turtkul, Shumanai and Nukus districts. It should be noted that until 2007 the incidence rate of the population living in the northern regions of Karakalpakstan was slightly lower than in the central and southern regions. Since 2008, there has been an upward trend in the incidence rate in the population from the northern regions, which is stabilizing to the present (Fig. 3). As for residents from the central and southern territories of Karakalpakstan, the polynomial trends of this nosology are also directed upward.

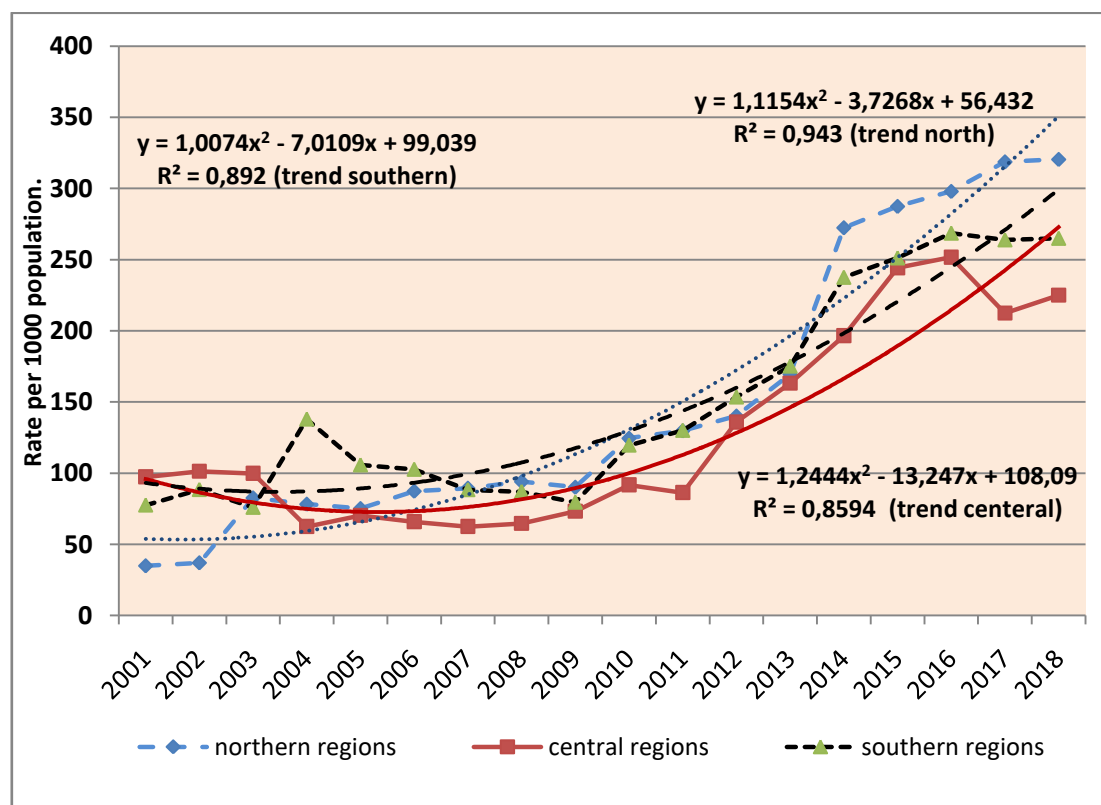


Fig. 3. The incidence dynamics of respiratory organs among the population by district differentiation Karakalpakstan

Comparative analysis of the structure of the general morbidity of the population of Karakalpakstan showed that if in 2010 the nosology of diseases of the blood and hematopoietic organs makes the largest contribution to the overall structure of morbidity (44.7%), the share of diseases of the respiratory system was 15.3%, the share of diseases of the endocrine system was 7.8, the digestive system - 6.2% (Fig. 4). The analysis of the structure of the distribution of nosological forms of diseases in 2020 showed that there is some redistribution of the main nosologies. Thus, the proportion of diseases of the blood and hematopoiesis system was 26.9%, at the same time there is an increase in the overall structure of morbidity in the proportion of respiratory diseases - 25.5%. The proportion of such diseases as the digestive system, the genitourinary system and the endocrine system was distributed almost equally (8.3; 7.3 and 6.4, respectively). The diseases proportion of the circulatory system in 2020 is slightly increased compared to 2010.

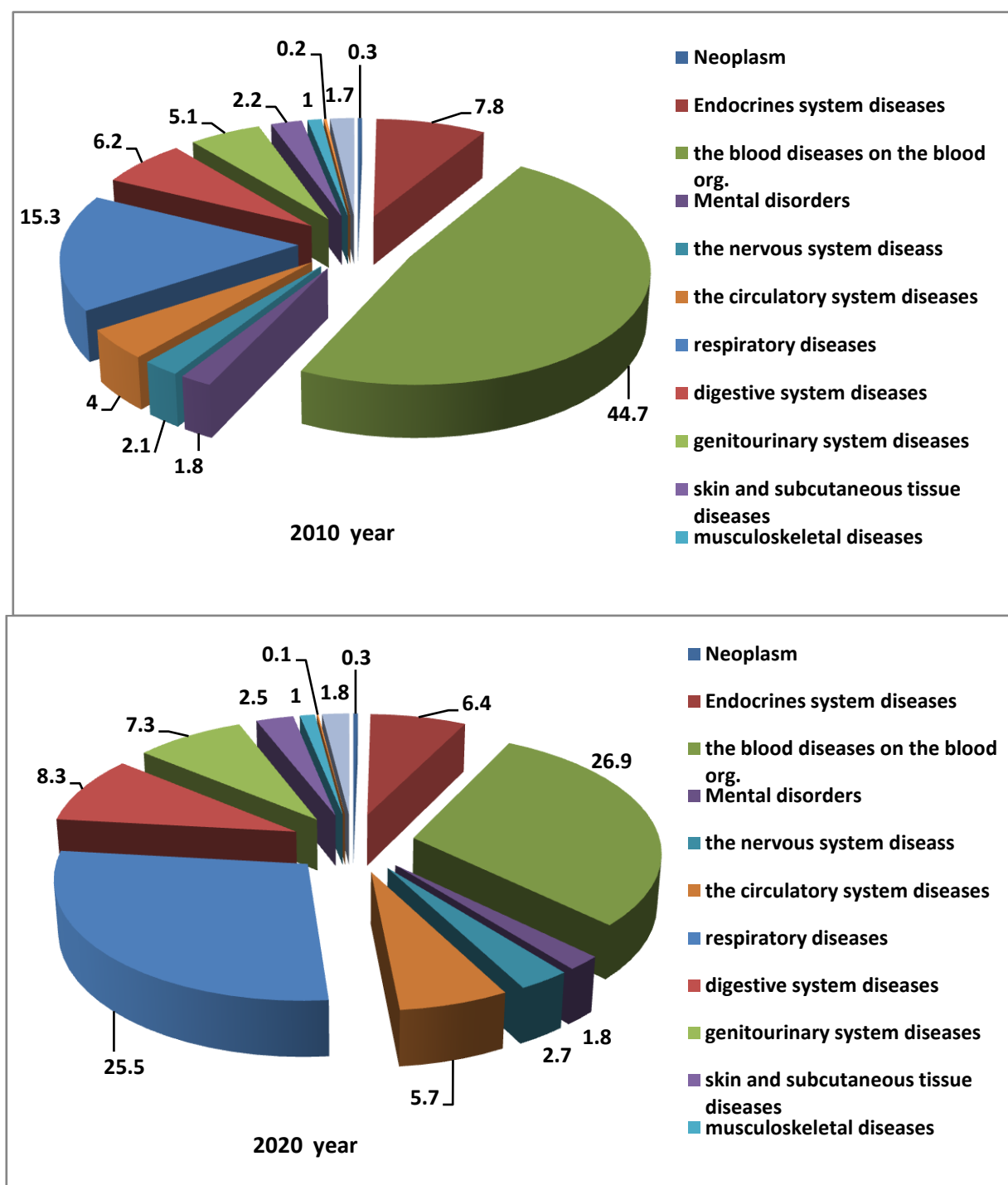


Figure: 4. Comparative analysis of the morbidity structure of Karakalpakstan population, %

Environmental factors are considered as risk factors, i.e. such components of etiology, which, although important for the disease development and progression, in them, in the other conditions absence, are not capable of causing a disease in a particular person. The analysis revealed reliable correlations between the levels of some parameters of the composition of drinking water and atmospheric air with the general morbidity of the adult and child population of Karakalpakstan. So we have identified a correlation with the composition of atmospheric air, namely with sulfur dioxide, a weak correlation ($R = 0.18$), with nitrogen dioxide ($R = 0.66$), with the dustiness of the surface air layer ($R = 0.54$).

Drinking water quality also correlates with the overall morbidity of the population: with chlorides in water, ($R = 0.43$) and with sulfates in water ($R = 0.73$). The overall morbidity in the child

population is closely related to the quality of drinking water (with sulfates in water $R=0,83$ and with chlorides in water $R=0,52$). Correlation with air pollution was revealed: with nitrogen dioxide ($R=0,58$), with dust ($R=0,53$). The environment, although composed of individual components, acts as a whole, and the effect of the whole is always greater than the effect of the sum of the individual parts.

The obtained regression equations indicate a direct dependence of the general morbidity level in the child population on the total air pollution degree: the more significant the air pollution degree, the higher the morbidity level. (table2).

Table 2.
Regression statistics and analysis of variance

Settlements	Coefficients		Fisher's criteria, F	
	multiple correlation, R	determination, R^2	F estimated	significance F
Northern regions	0,922	0,904	5,58	0,17
Central areas	0,94	0,925	12,69	0,08
Southern regions	0,931	0,91	6,08	0,09

The coefficients value of determination can be interpreted as follows: the constructed regression for the central regions of Karakalpakstan explains 92.5% of the spread of values relative to the average, for the southern regions - 91.0% and for the northern regions of the republic - 90.4%. Thus, the studies carried out have shown that poor-quality drinking water has a significant impact on the health of the population living in conditions of an aggravated environmental situation in the Aral Sea region.

It has been established that water with increased hardness has a greater effect on the increase in cardiovascular diseases, digestive and excretory systems of the human body.

Thus, anthropogenic changes in natural conditions and negative changes in the socio-ecological situation in the Aral Sea region are an irrefutable fact. When developing stabilization measures, measures to mitigate the environmental situation, it is necessary to proceed from priority positions: water use rationalization, surface water quality improvement, reduction of chemical loads on the region, improvement of population living conditions.

In the extreme conditions of the Southern Aral Sea region under the multiple factors influence of low intensity, there is an urgent need to develop methods for identifying pre-pathological body conditions. This, firstly, will make it possible to timely identify the people contingents at potential danger risk in order to timely carry out the necessary preventive measures, and secondly, to determine the danger degree of the certain diseases occurrence and predict certain pre-pathological changes for the body.

Thus, the considered influence of environmental factors on the health status of the population in all cases is complex. Moreover, the nature of their action can be unidirectional and multidirectional. From an ecological point of view, this is explained by the fact that shifts in the functional state of the body are more sensitive to the environmental factors action than the incidence itself. For the main considered nosological forms and groups of diseases, selectivity was revealed in relation to various factors, which makes it possible to build a strategy of preventive actions and develop specific recommendations for decision-making bodies.

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