



Socio-economic and public health impacts of climate change and water availability in Aral District, Kyzylorda Region, Kazakhstan

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ABSTRACT

The research aimed to investigate the impacts of climate change and water availability on the socio-economic aspects and overall health of the population in Aral District of Kyzylorda Region of the Republic of Kazakhstan. The study focused on the following indicators: demographic characteristics of fertility, mortality (total, infant, maternal), natural population growth and life expectancy, population health indicators, disease incidence growth due to adverse ecology and harsh climate in 2005-2019. In addition, a sociological survey was conducted (August 31-September 10) in 15 settlements inside the study area that included 120 people. The survey aimed to collect feedback from the district residents on their general wellbeing and health status. The questionnaires and survey allowed establishing that overall the residents in the study area were satisfied with their level of income, did not associate their health condition with climate change, and did not intend to migrate elsewhere. In other words, in Aral District of Kyzylorda Region population migration occurs mainly due to the desire to obtain secondary and higher education, as well as improve housing conditions. The water supply in the study area showed no significant regression relation with climate change due to the installation of water pumps and delivery of drinking water by tank trucks. The most important finding is that - contrary to the initial hypothesis - based on the survey outcomes, the district demonstrated a stable increase in population due to births and immigration. Thus, according to this study Kazakhstan’s section of the Aral Sea Region manifests no catastrophic situation.

KEYWORDS

shallowing, population migration, health, sociological survey, economics.

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1. Introduction

Especially after the 26th Conference of the Parties (CoP) to the UN Framework Convention on Climate Change (UNFCCC) in Glasgow in 2021, the influence which climate change exerts over various spheres of life of societies has become one of the most serious global challenges of the 21st century. It manifests a complex interdisciplinary phenomenon running a golden thread through the environmental, economic, and social aspects of sustainable development: from public health quality to the state of economy.

The fall of the water level in the Aral Sea and its increased mineralization have intensified the amplitude of annual water temperature fluctuations and shifted the phases of its temperature regime. In its turn, these brought down the quality of the living environment and socio-economic conditions for over 500 thous. people residing in Kyzylorda Region of Kazakhstan. For decades, local communities have used drinking water with excessive salt and pesticide content. At present, sand and dust storms (SDS) are rather common; jobs and additional natural food sources are dwindling (hunting and commercial animals are disappearing due to shrinking tugai woods and tallgrass); the Aral Sea, as well as rivers, lakes, and other water bodies in the region have lost their fishery significance; soil fertility is worsening and crop yields are falling. These and other climate-induced changes have led to various demographic processes and affected the health status of the population, subsequently propelling migration to more developed areas of the country.

The growing shortage of natural resources around the world, risks associated with droughts and floods, as well as rising ocean level are capable of forcing millions of people to migrate (Weitzman, 2007). It is known that the external environment, natural and climatic conditions determine 17-20% of human health, 48-53% depend on lifestyle, 18-22% on genetics, and 8-10% on healthcare (Mukasheva, 2015). In addition, determining the dependence of public health on environmental conditions should be done dynamically, based on a long-term analysis, and with the account of ecosystem changes taking place in a given territory. The state of public health in the Aral Sea Region may have been affected by its drying that led to the formation of an unfavorably sharp continental climate characterized by frequent SDS. The aftermath of this environmental disaster included burgeoning unemployment and poverty exacerbated by the economic collapse and disintegration of the healthcare system after the collapse of the Soviet Union. Increased soil salinity, frequency and scale of SDS and water mineralization all adversely affected the quality of life and health of local residents, pushing them away to other Kazakhstan's constituencies with more favorable living conditions. In addition, heavy application of fertilizers, herbicides, pesticides, and defoliants in cotton growing has led to these chemicals'

retention in the ecosystems and food chain, washing downstream and concentration in close proximity to the Aral Sea (White, 2013).

This study aimed to analyze the impacts of climate change, water availability and consequences of the drying of the Aral Sea on the welfare, including its social, economic and public health aspects, based on the perceptions of the Aral Sea Region population.

2. Literature review

According to the World Health Organization (WHO), socio-economic and environmental conditions, such as availability of own housing, employment among the population, public healthcare and water quality, etc. shape the overall state of population health (Turnock, 2012). The climate change policy discourse features various theories according to which management is based on the choice between acting now or waiting for society to learn more about an issue (O'Neill et al., 2006). The “waiting” choice leads to delayed decisions, which may bring about irreversible consequences. It is also essential to understand that natural and climatic risks are perceived differently in different socio-economic and political settings. For instance, it was found that the growth of economic risks and risks of increasing unemployment reduces public interest towards the risks associated with climate change (Benegal, 2018)

In addition, climate change serves an impetus for the emergence of environmental migration, a social phenomenon with quite a long history. As early as 1889, Ravenstein (1889) referred to migration as a phenomenon associated with unfavorable climate. Later, Roorbach (1911) argued that “the search for better lands, milder climate and easier living conditions [is] the reason for the movement of people, which - given their aims - leads them to an environment significantly differing from their former habitat”.

Migration can be caused by deteriorating public health due to environmental conditions and harsh climate in an area (Chindarkar, 2012). According to WHO, a quarter of all diseases develop as a result of environmental impacts. WHO also lists the following main disorders, the emergence of which is associated with poor state of ecology and unfavorable climate: upper respiratory tract (URT), blood system, gastrointestinal tract (GIT), and endocrine system (ES) diseases.

In their turn, immunology and allergology researchers argue that the spreading impacts of unfavorable anthropogenically driven ecosystem changes negatively affect human physiology in the form of acute diseases (Schober, Behrendt, 2008). The study by immunologist Ubaidullayev (1994) revealed that URT disorders represent the most sensitive indicator of the effects which poor ecology and severe climate

impose on human health as a result of certain concentrations of harmful substance and salts in the atmosphere. Along with this, the impacts of environmental factors manifested at the level of other systems - endocrine, immune, intestinal microflora, hematopoietic, etc. - cannot be denied either. Thus, the studies by Kovalenko et al. (2010) demonstrate that “none of the endocrine pathologies is associated with environment as close as thyroid diseases, and therefore thyroid pathologies can be rightfully considered a marker of environmental deprivation” (environmental ill-being).

Among the local studies, it is worth highlighting the interim monitoring of the Project “From environmental disaster to the revival and prosperity of the Aral Sea Region” implemented by the Regional Center for Ecology and Public Health Protection of the Aral Sea Region (NGO) led by S. Seitov (2016). The monitoring exercise aimed to detect the impacts of ecology and drinking water in the target region on disease incidence among local residents. The project experts confirmed the direct adverse influence of ecosystems, climate and drinking water on the occurrence of respiratory, blood and other acute diseases in the studied population. Moreover, as per the official statistics of the Ministry of Health (MoH) of the Republic of Kazakhstan (RK), the Aral Sea Region occupies one of the leading positions in terms of diseases identified by WHO as most often caused by ecology, climate, and consumed water (poor quality and/or insufficient nutrient content).

3. Research area

3.1. Geographic location

By 2003, the volume of the Aral Sea went down to approx. 10%, and its surface area to about a quarter of the original. The coastline moved 100 km inward; water mineralization surged 2.5 times; and where once there was the sea, the salt-saturated Aralkum Desert emerged.

The North Aral Sea is a small and shallow water body in Kyzylorda Region (Kazakhstan), which until 1960s made up about 1/9 of the total sea area and was integrated with the present-day South Aral Sea. The depth of about 42% of the North Aral Sea area is 10-20 m.

The study mission to investigate the socio-economic conditions and water availability in the target region (Aral District of Kyzylorda Region), as well as health status of local residents took place during August 31-September 10, 2020. In total, the study team visited 15 (fifteen) communities: town of Aralsk, villages of Aralkum, Zhaksykylysh, Shomish, Kamystybas, Amanotkel, Raim, Yeskiura, Kyzylzhar, Shomishkol, Zhanakurylys, Akkulak, Bogen, and Karashalan (Fig. 1).

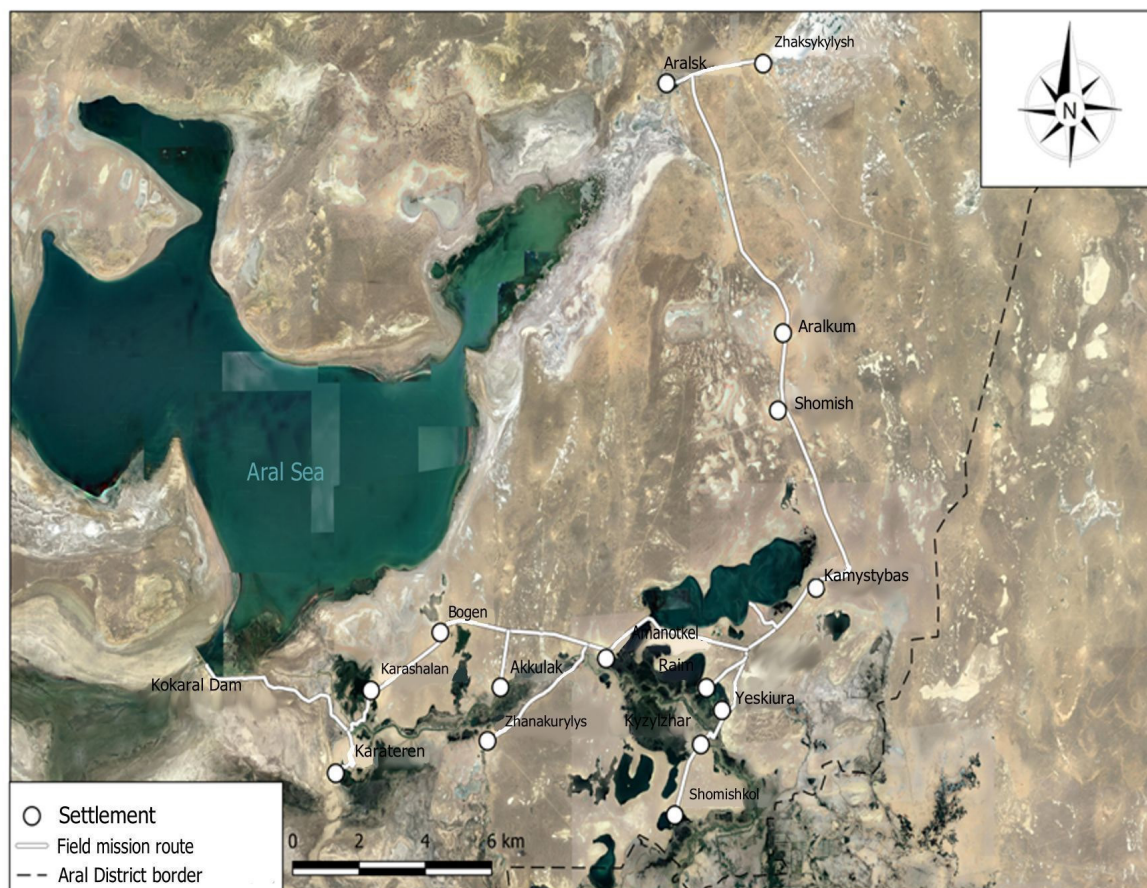


Figure 1. Research field mission route (source: Google Maps, 2020).

3.2. Climate

Uncontrolled water consumption for irrigation has turned the Aral Sea into barren desert (Aladin et al., 2004). The shallowing of the sea resulted from climate change that took place in the Aral Sea Region: the local climate became sharply continental. The sharply continental arid climate manifests the main critical natural and climatic factor characterized by significant daily and yearly temperature fluctuations with the absolute maximum of 46°C and minimum of -27°C . Air dryness is accompanied by low rainfall (average 154-180 mm/year), not exceeding 120 mm/year in certain zones (Sakiyev et al., 2015). Huge amounts of dust containing sea salts, pesticides and other chemicals are wind-blown from the exposed dry seabed across the adjacent territories (Micklin, 2007).

Aridity is one of the hallmarks of local climate. The mean annual precipitation does not exceed 100-190 mm and is unevenly distributed among seasons - 60% of the total precipitation occurs during the winter-spring period. The entire target territory is characterized by frequent and strong, mainly northeastern, winds. Their mean annual speed ranges between 3.1 and 6.0 m/s. In winter, strong winds at low temperatures blow off the minor snow cover from elevated relief sections, causing

deep freezing and cracking of upper soil layers (Shkol'nik, I. M., Pigol'cina, G. B., & Efimov, S. V. 2016).

The shallowing of the Aral Sea in the Amudarya River Delta led to sharp environmental deterioration, desertification and soil salinity growth, posing a potential public health threat. Excessive use of pesticides and chemical fertilizers led to the pollution of surface and groundwater, with delta ecosystems virtually disappearing - by 1990, over 95% of wetlands and waterlogged lands had turned into sandy deserts, and more than 50 delta lakes (original area of 60 thous. ha) had dried up (Yevtushenko, 2009).

4. Research methodology

Within the framework of this study, the following data were analyzed for the period of 2005-2019: birth and mortality (general, infant, maternal) rates, natural population growth and life expectancy, unemployment rates, wages, public health indicators, disease incidence dynamics due to unfavorable ecology and harsh climate.

The data on demography, socio-economic indicators and public health were obtained from the Regional Department of Statistics and Republican Digital Health Center (RDHC), WHO, NGO "Regional Center for Ecology and Public Health Protection of the Aral Sea Region", Statistics Committee of the Ministry of National Economy (MNE) of the RK, and local executive authorities. The retrospectively analyzed period - 2005 to 2019 - covered 14 (fourteen) years. The comparative historical analysis was done against the 1991 values.

As part of the ESERA Project, 120 local residents were surveyed in the target settlements in 2020 (Fig. 1.). The questionnaire was designed to allow assessing the region-specific impacts of climate change on the living standards and welfare of the local population, scale and causes of migration from the region, and health of local residents.

Methodologically, the study represented a comparative analysis of the official data obtained from state agencies (e.g. Statistics Committee of Kyzylorda Region) and non-governmental organizations against the primary sociological information collected as the result of survey (questionnaire-based) among local residents of the Aral Sea Region.

5. Key socio-economic indicators for Aral District, Kyzylorda Region, in 1991-2019

Population

The long-standing tradition of having large families common in southern Kazakhstan supports the national-level birth rate, i.e. 21.3 births per 1,000 persons (during the study period).

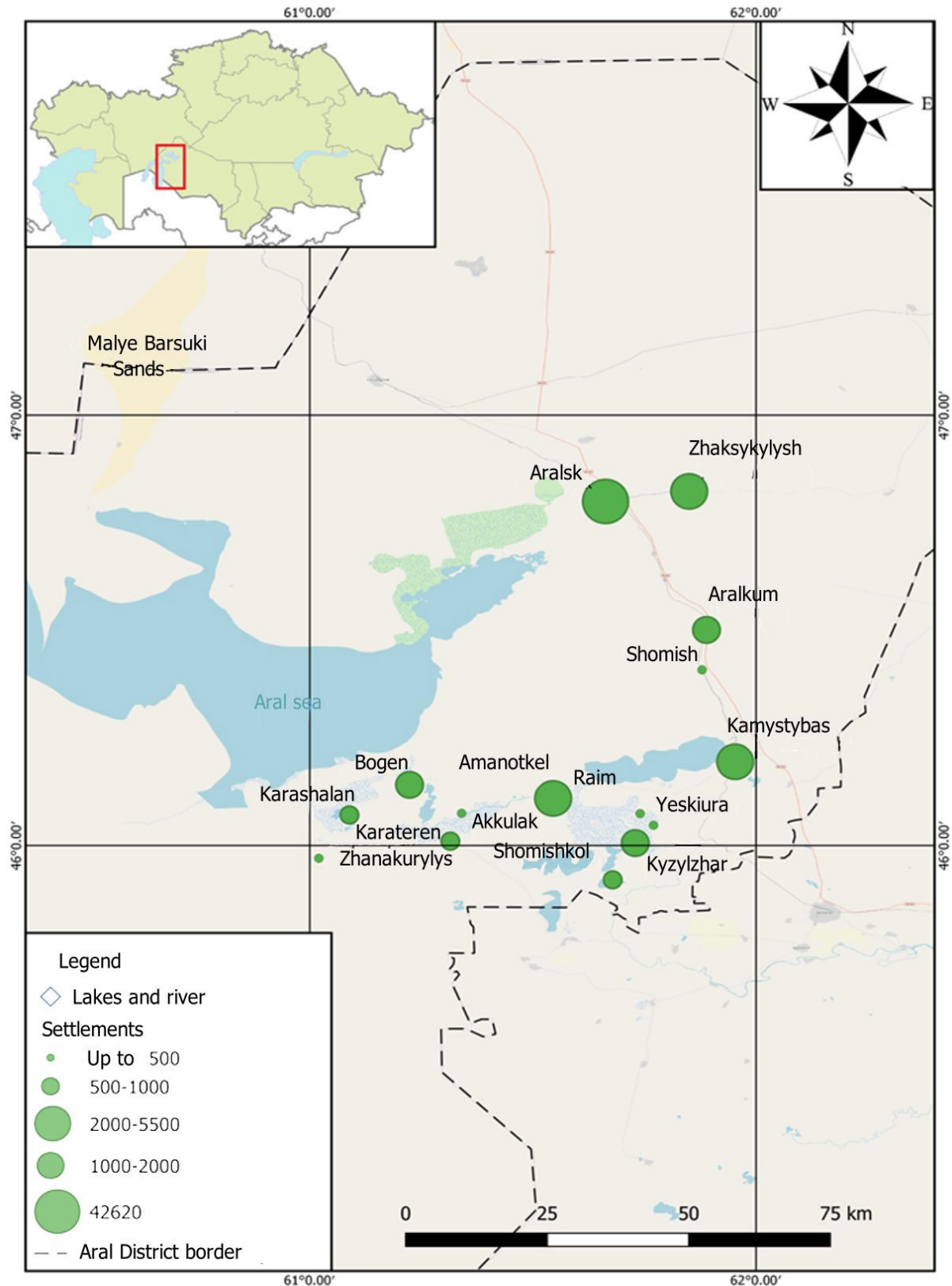


Figure 2. Aral District population (source: Open Street Map, 2020).
According to the Statistics Committee, in 2019 the population of Kyzylorda

Region amounted to 802.8 thous. people, including 358.8 thous. (44.7%) in urban and 443.9 thous. (55,3%) in rural communities. Correspondingly, in the same year the population of Aral District was 79,600 people (Fig. 2.).

At present, Kyzylorda Region is demonstrating a stable trend of population growth. Thus, having peaked in 2008 (32.02), the birth rate began to slightly decline, although remaining consistently high - approx. 26 births per 1,000 persons. The mortality has been showing a declining trend from 7.2 (2009) down to 5.68 (2019), making the natural population growth rate about 20 (Fig. 3.).

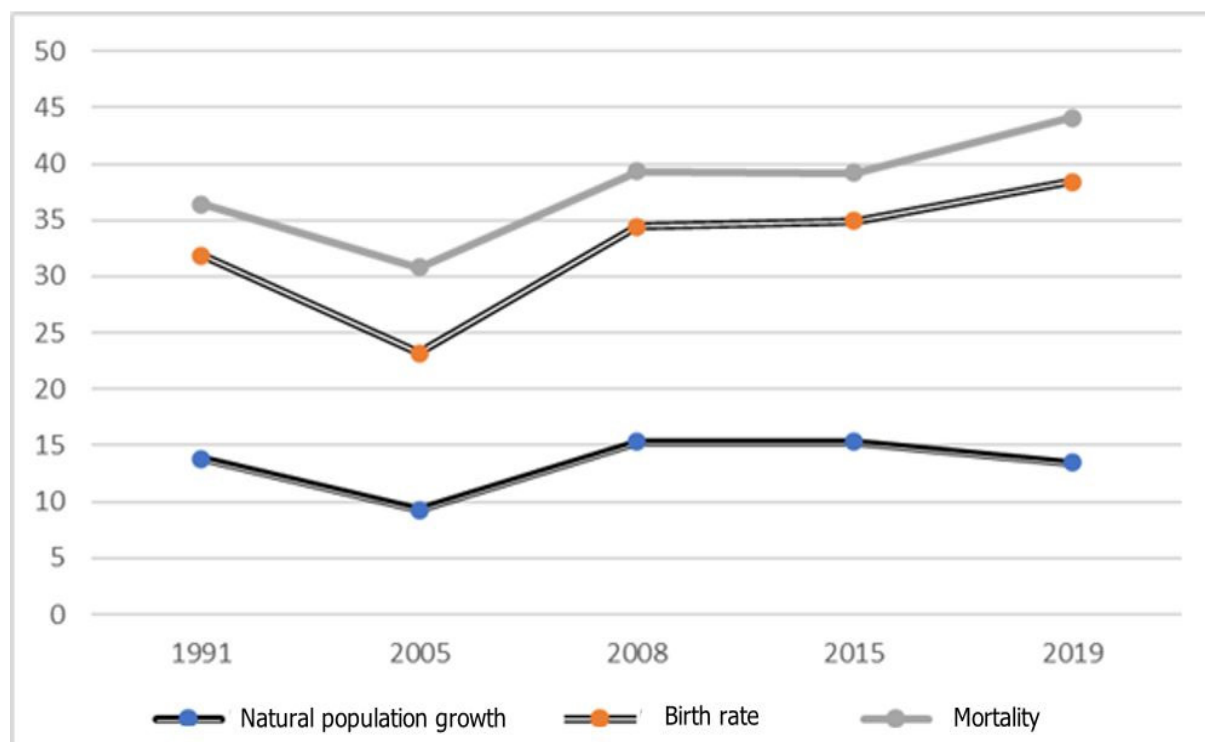


Figure 3. General demographics in Kyzylorda Region (source: Kyzylorda Region Department of the Statistics Committee of the RK).

Overall, the study area is demonstrating a stable population growth. Whereas in 2005 its population amounted to 13.6 thous. people, in 2015 it was already 15.5 thous. people, with a slight decline down to 14.6 thous. in 2018. Currently, the village of Zhaksylysh is the largest (5 thous. residents) settlement in Aral District, followed by Amanotkel (2.5 thous. residents), and Kamystybas (1.9 thous. residents).

Mortality is one of the most important demographic indicators. In all study districts, mortality was 1.5 times lower compared to the national-level average. As to natural population growth, the country mean over 10 years amounted to 11.8 deaths per 1,000 persons per year. The mean infant mortality rates (number of children dying under the age of 1 year per 1,000 live births) over 10 years (2004-2013) in the entire Kazakhstan and target districts of Kyzylorda Region are shown in

Fig. 2. Thus, whereas Kazakhstan's mean was 15.6%, in the study area it was 10-20% higher. The most pronounced excess of infant mortality was observed in Aral and Shiyeli Districts.

6. Public health in the Aral Sea Area, Kyzylorda Region

Climate and environmental factors are among the most common affecting public health, especially in ecologically distressed regions. The Law of the RK №1468-XII "On Social Protection of Citizens Affected by the Aral Sea Environmental Disaster" of June 30, 1992 (On Social Protection..., 1992) declared the territories adjacent to the Aral Sea as environmental disaster zone.

The main region-specific unfavorable environmental and climatic factors include the sharply continental arid climate characterized by significant temperature fluctuations in summer (up to 50°C) and winter (down to -30°C) and low precipitation (average 154-180 mm/year). These phenomena cause air dryness and strong winds, in their turn, leading to sand/salt/dust storms boosting the concentration of air-suspended harmful substances (Wang et al., 2020). These factors have varying degrees of influence on the health status of the local population.

It is known that the external environment, natural and climatic conditions predetermine 17-20% of human health condition, 48-53% depend on the lifestyle, 18-22% on genetics, 8-10% on healthcare (Lin et al., 2017). Table 5. below shows known and proven cases of weather and climate effects on human health.

According to WHO, there are several known environmental and climate impacts on human health. For example, weather and concentration of harmful substances in the air facilitate the development of respiratory and URT diseases; exposure to drought causes disturbance of nutrition and metabolism processes, as well as GIT disorders. There are also waterborne diseases dependent on water quality, in turn, affected by climate. Quality assessment at all levels is called biological assessment of environment impacts on living organisms, including humans.

Child population health represents an illustrative and cumulative indicator demonstrating the overall influence of ecological and climatic conditions on the entire population.

Currently, Kyzylorda Region ranks second in terms of infant mortality (0-5 years old) and first in rural infant mortality (Pena-Boquete et al., 2019) (Fig. 4.), and exceeds the national average by at least 20%.

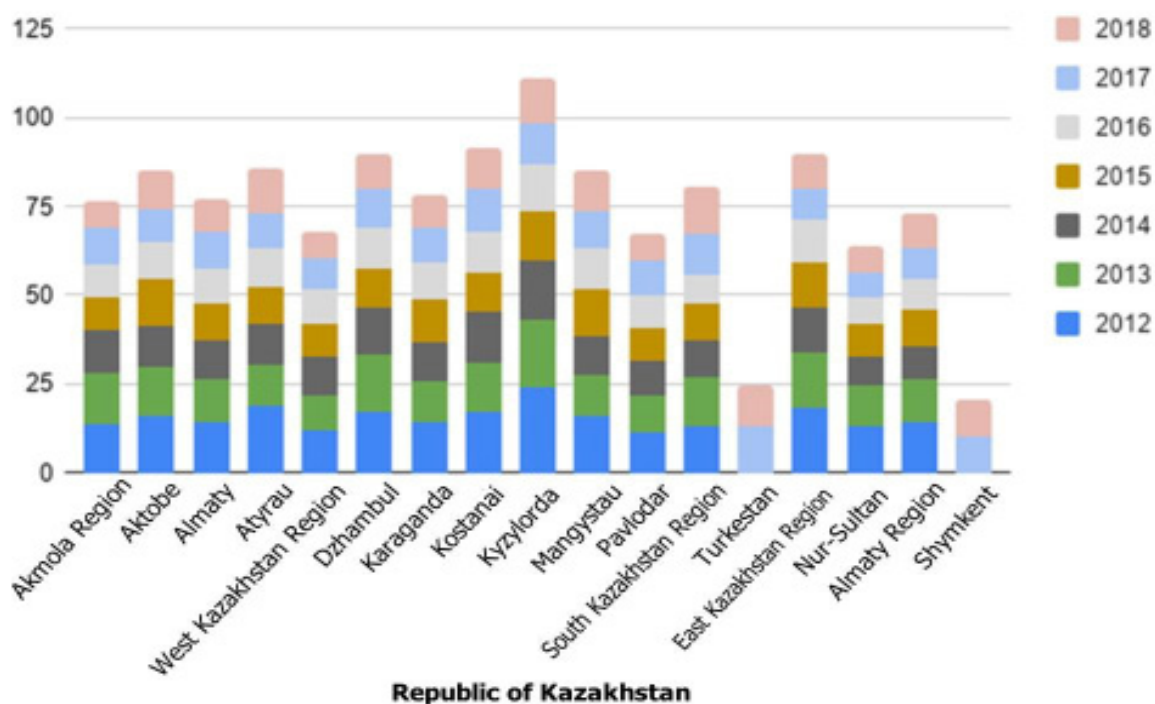


Figure 4. Region-disaggregated mortality in rural children under 5 years old per 1,000 live births in 2018 (source: Project “Healthy childhood and socio-economic situation in Kazakhstan”, M. Narikbayev KAZGUU University (Makhmejanov, 2017)).

As to the main causes of child mortality under 5 years old, in 2017 the maximum values exceeded the national means for URT (over 70%) and anemia (over 6.8%) diseases (Fig. 4.). According to the World Health Organization, these diseases are directly related to the state of the environment and climate conditions (WHO, 2006).

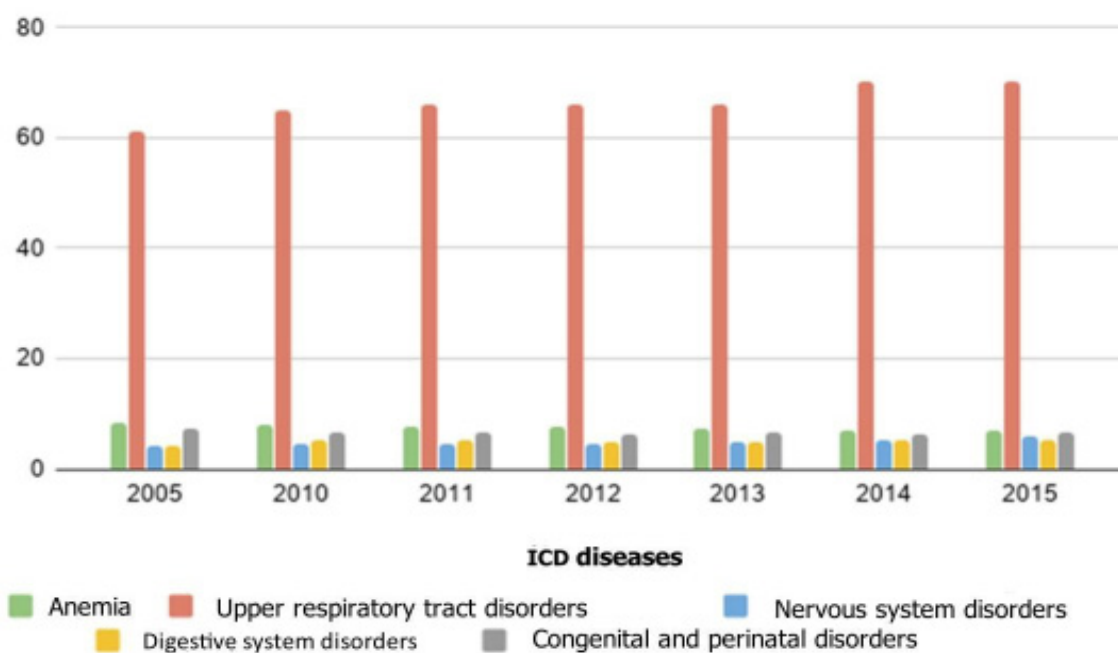


Figure 5. Causes of mortality in children 0-5 years old per 100,000 persons (source: Statistics Committee of the MNE of the RK (UNICEF, 2008)).

Kyzylorda Region occupies high positions in the ratings for multiple diseases, in particular, the following groups: blood, URT, metabolic, and digestion disorders. As for rural communities, regardless of age and gender, the Aral Sea Region is the national leader in the number of registered cases of blood diseases. The most often registered cases are iron deficiency anemia - the condition directly related to the lack of iron and nutrients in human body obtained through food and water (Fig. 6.).

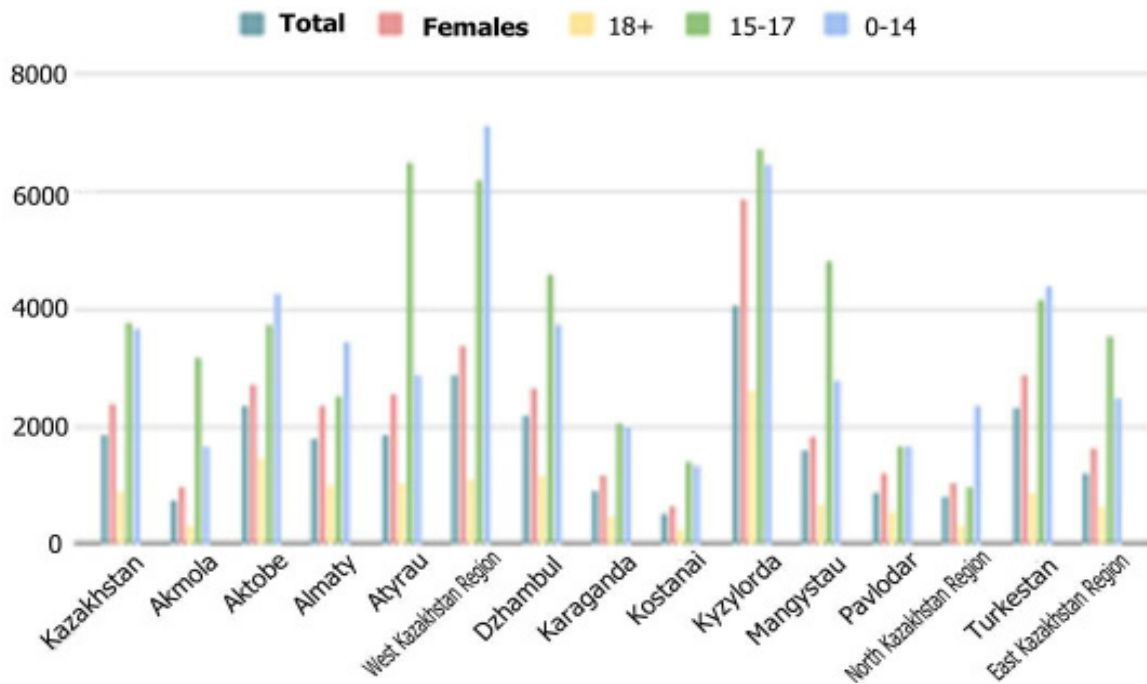


Figure 6. Region-disaggregated blood disease (anemia) incidence in rural residents of Kazakhstan in 2018 (source: Statistics Committee of the MNE of the RK (UNICEF, 2008)).

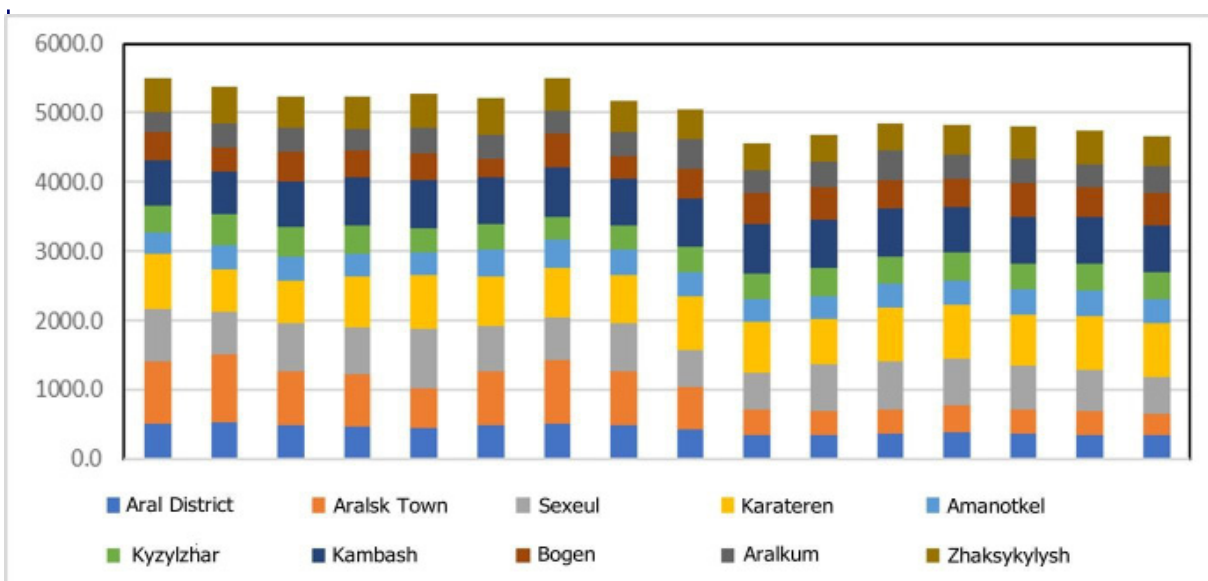


Figure 7. Blood disease incidence in the study settlements in 2004-2019 (source: Aral District Akimat).

The study allowed harvesting data (2004-2019) from the outpatient clinics in 9 (nine) following target settlements: town of Aralsk, and villages of Saxaul, Karateren, Amanotkel, Kyzylzhar, Kambash, Bogen, Aralkum, and Zhaksykylysh.

In general, 9 (nine) settlements in Aral District demonstrate a stable decline in the number of blood disease cases (Fig. 7.), with the lowest rates observed in the town of Aralsk (3,078.1 cases in 2019). The village of Kambash showed the highest incidence with twice as many diagnosed cases (6,754.7) as in the administrative center of Aralsk.

Digestive system disorders, especially dysbacteriosis, are especially common among the rural population of Kyzylorda Region (Fig. 8.). Digestive system issues are directly related to the consumption of poor quality water and lack of nutrients obtained mainly from locally produced foods.

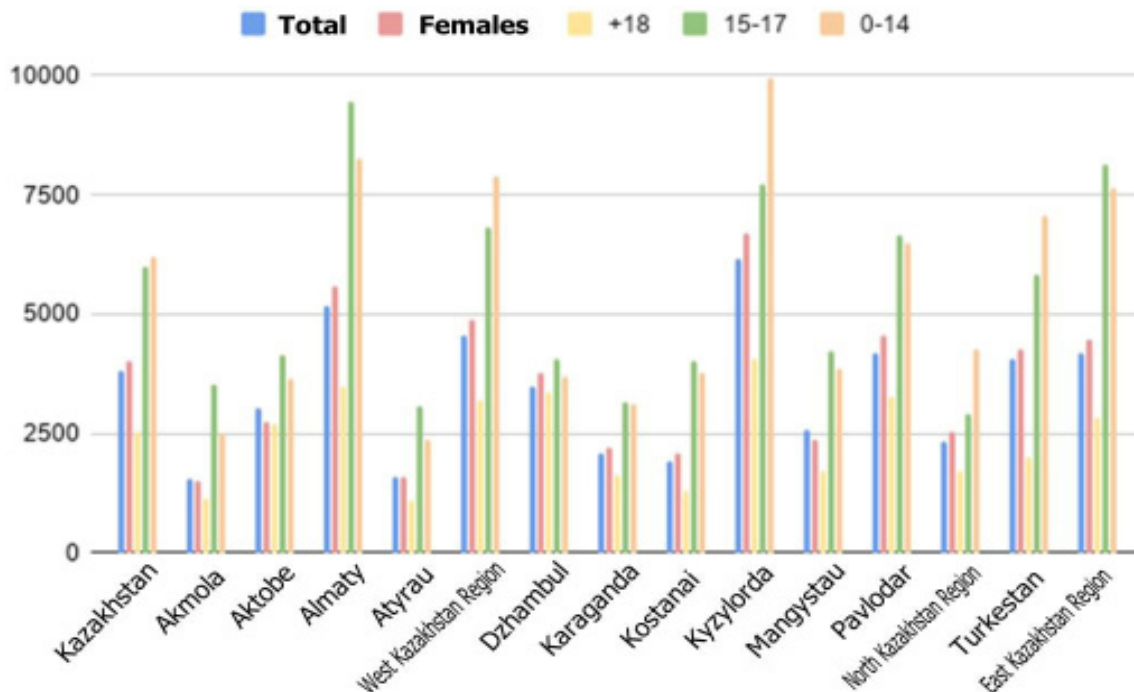


Figure 8. Region-disaggregated digestive system diseases in the rural population of Kazakhstan in 2018 (source: Statistics Committee of the MNE of the RK (UNICEF, 2008)).

Disaggregated by communities (villages), whereas the lowest digestive disorder incidence was observed in Zhaksykylysh (5,911.8 cases), the highest number of GIT cases was detected in Karateren (11,741.4 cases) (Fig. 9.).

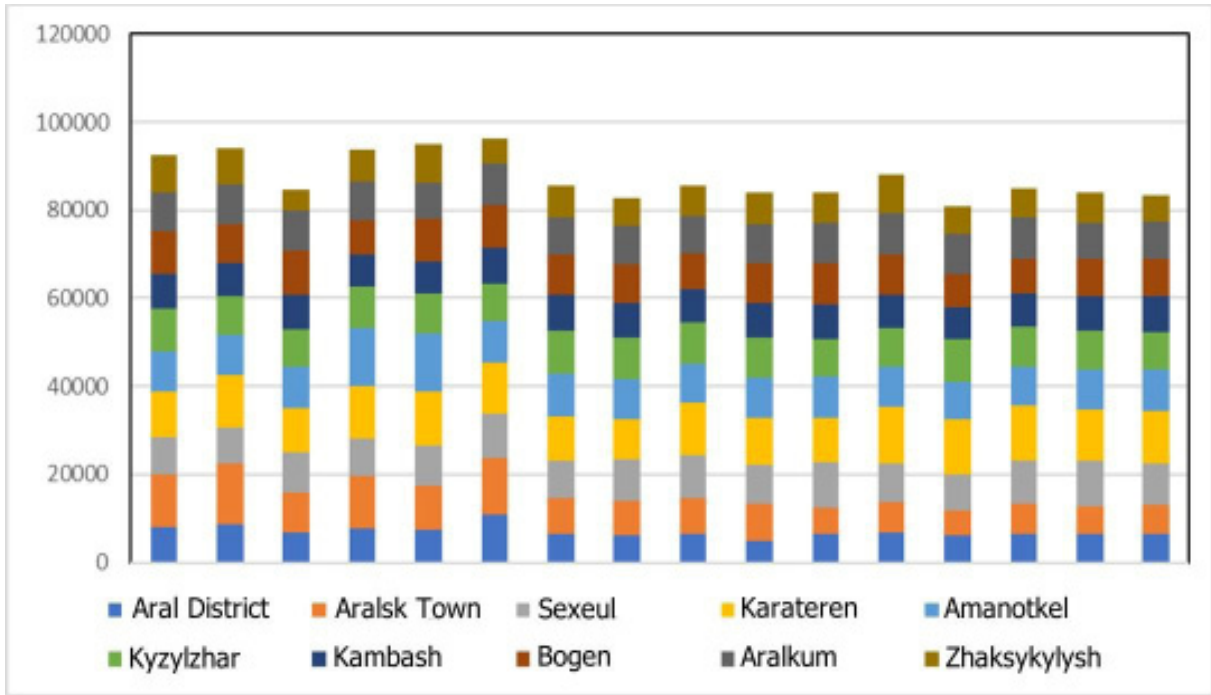


Figure 9. Digestive system diseases in the study settlements in 2004-2019 (source: Aral District Akimat).

The next in the ranking are the URT diseases (asthma) - in 2018, in terms of registered cases the rural population of Kyzylorda Region ranked 5th across the country (Fig. 10.). The rather high asthma incidence may be stimulated by the local arid climate stressful for human respiratory system.

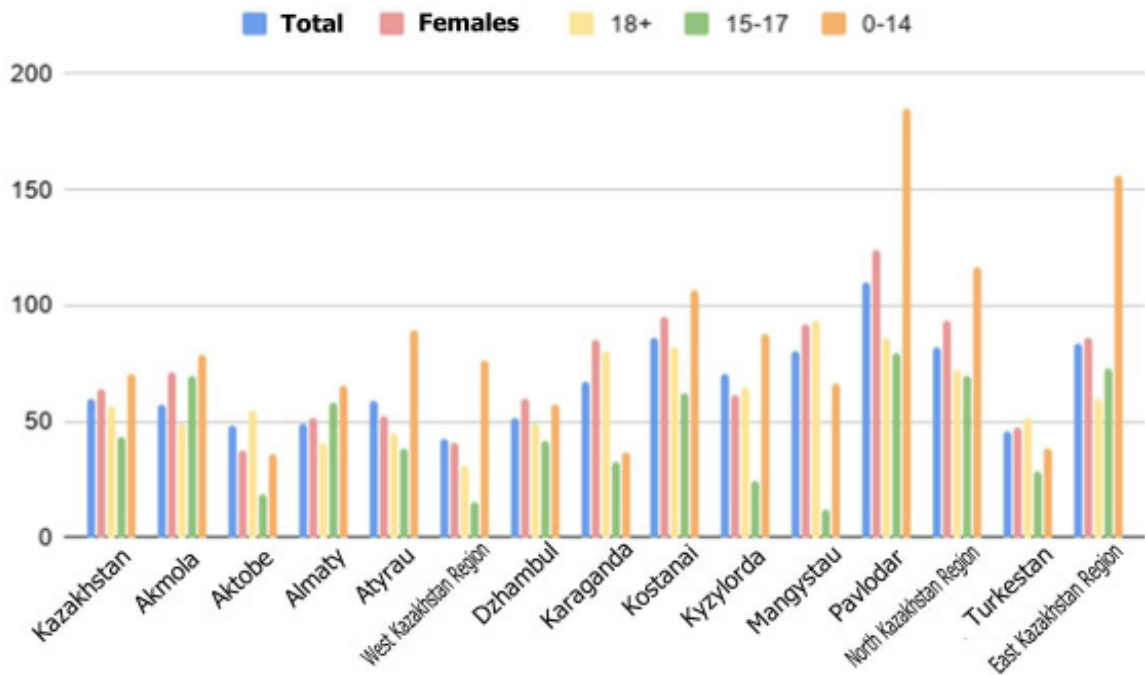


Figure 10. Region-disaggregated incidence of URT diseases (asthma) in the rural population of Kazakhstan in 2018 (source: Committee of the MNE of the RK (UNICEF, 2008)).

The village profile of URT cases is shown in Fig. 11. demonstrating a stable prevalence decline over the past 5 years. In 2019, the town of Aralsk ranked first in terms of the number of registered cases (24,574.4). A positive trend - falling incidence - was likewise seen in Kyzylzhar (20,307.4).

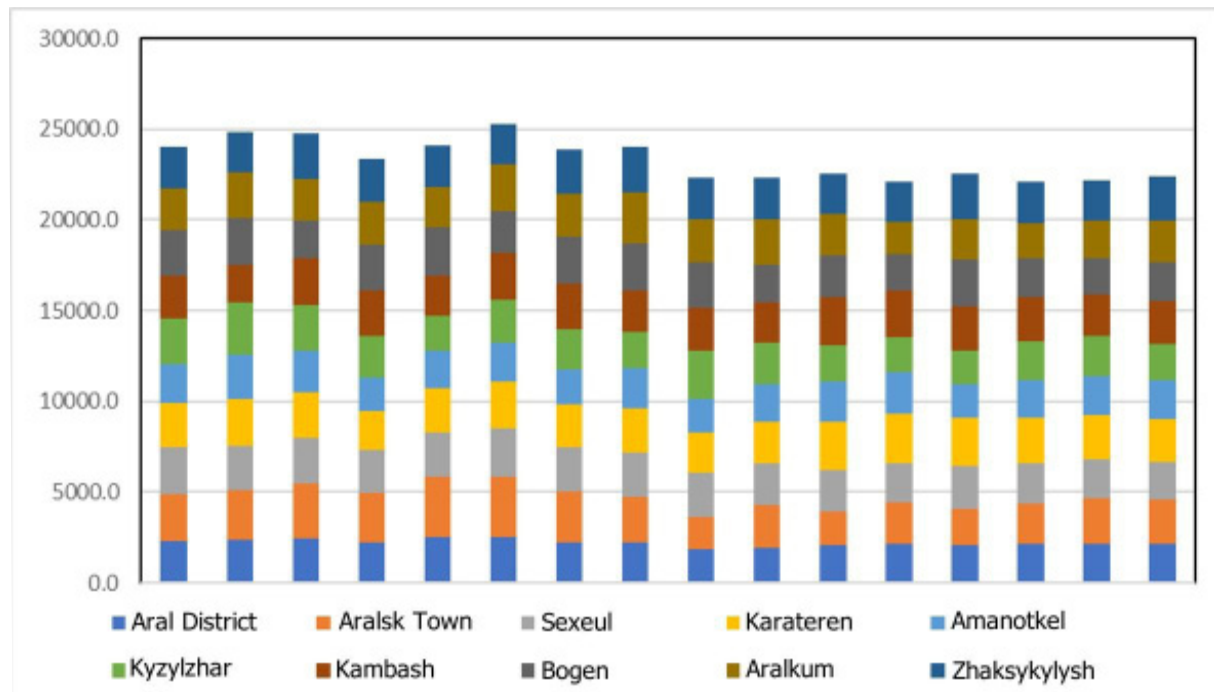


Figure 11. URT diseases in the study settlements in 2004-2019 (source: Aral District Akimat).

External factors, including environmental and climatic conditions, also directly affect the absorption of nutrients and trace elements which the human body obtains from food and water, as well as proper metabolism. However, according to the Ministry of Health (MoH) of the RK, the rural residents of Kyzylorda Region suffer from endocrine system, nutritional and metabolic disorders, making the region the leader in the number of registered cases in Kazakhstan (Fig. 12.).

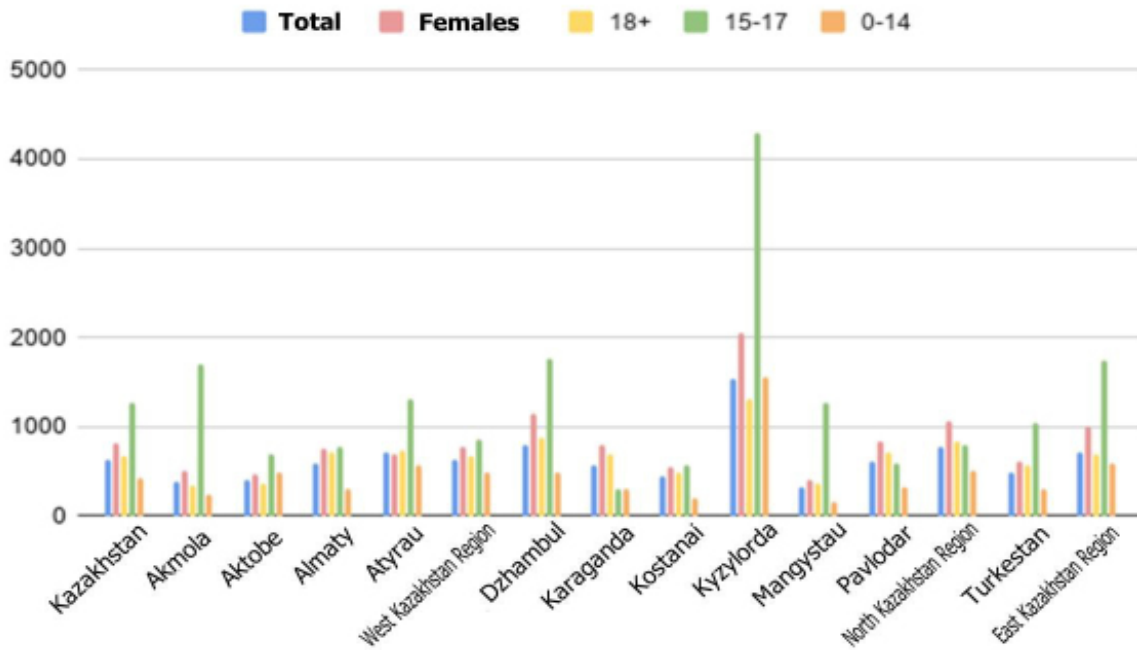


Figure 12. Region-disaggregated ES, nutritional and metabolic disorders in the rural population of Kazakhstan in 2018 (source: Statistics Committee of the MNE of the RK (UNICEF, 2008)).

Overall, the prevalence of ES diseases among the residents of target settlements appeared unstable, although over the past 3 years a slight decline in the number of registered cases was observed. The highest (1,701.7 cases) prevalence was recorded in the village of Saxaul, and the lowest (187.4) in Aralkum.

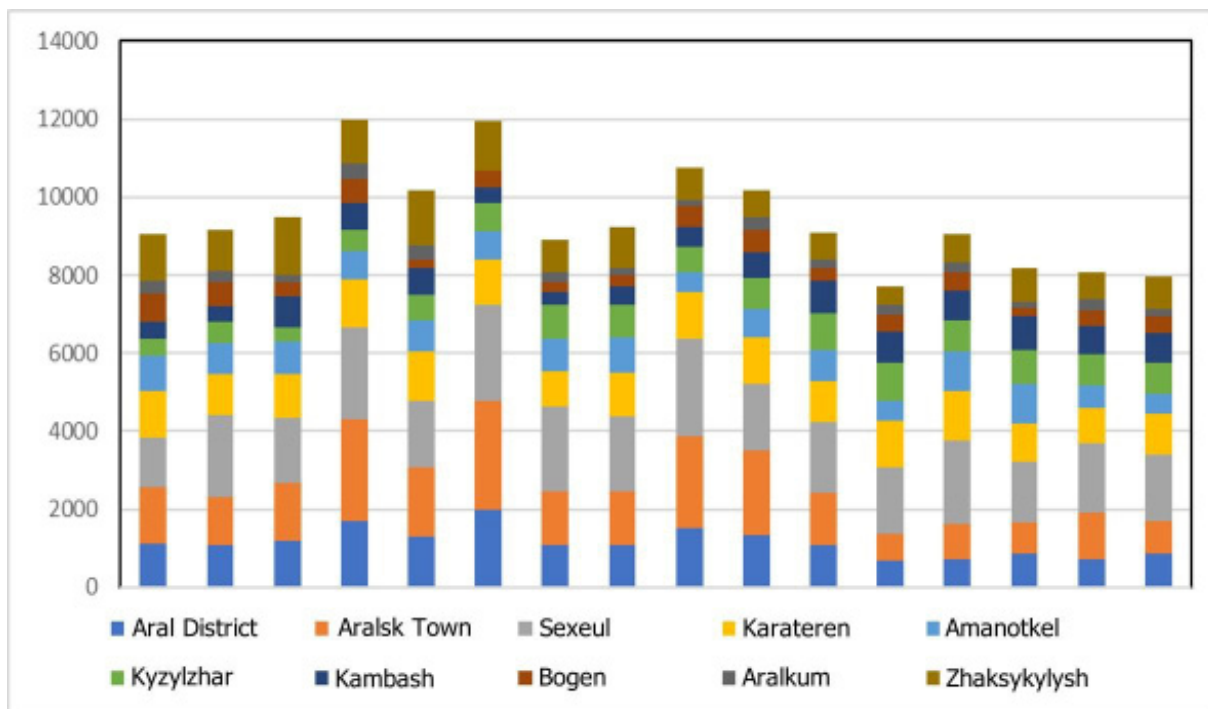


Figure 13. ES diseases in the study settlements in 2004-2019 (source: Aral District Akimat).

The impact of drinking water quality on local public health represents the most controversial indicator. According to statistics, absolutely all water quality parameters did not exceed the permissible thresholds. For instance, as per the official statistics provided by the local government in 2019 the quality parameters for the well water in the village of Sarybulak were the following: iron content - 0.3 mg/dm³ (permissible concentration of 0.3 mg/dm³); salt content - 430 mg/dm³ against the permissible concentration of 1,000 mg/dm³; total microbial count - 15 cfu/ml against the permissible level of 50 cfu/ml; total hardness of water - 1.5 mol/dm³ (permissible threshold of 7.1 mol/dm³); hydrogen content - 7 mg/dm³ against the permissible concentration of 9 mg/dm³. Thus, it can be inferred that the water consumed in the region does not pose risk to public health.

The official statistical data, therefore, indicate certain issues in the region with blood, gastrointestinal tract, upper respiratory tract, and endocrine system disorders primarily associated with unfavorable environment. Yet, the annual decline in their prevalence and child mortality clearly points to an overall positive trend. Furthermore, the quality of public health in the region can be further stabilized by holding various events by eco-volunteers, NGOs, as well as under government programs aimed at improving the quality of medical services and access to them, not to mention various health-related events for children, adolescents, senior citizens and other population groups.

7. Region's economic indicators: quality of life and labor market

Based on the 2005 statistics, the income of 47.7% of Kyzylorda Region population was below the subsistence minimum, and sequentially decreased down to 4.4% by 2019.

The unemployment rate in 2005 was 9.7%, 6.9% in 2008, and showed a declining trend in subsequent years - 5.5% in 2011, 5.0% in 2015, and 4.8% in 2018.

According to the 2019 data, the economically active rural population amounted to 348.2 thous. people, including 331.7 thous. people employed, of which 114.2 thous. were self-employed. Compared to the corresponding period last year, the total rural population decreased by 14,364 persons (3.5%), the economically active population decreased by 7,149 persons (3.5%), the employed population - by 3,182 persons (1.7%), including the self-employed (4,234 persons or 5.2%). The main reason for the sharp drop in the number of rural population, including its economically active share, was that in 2007 the villages of Tasbuget and Belkol changed their status and became urban settlements.

In percentage shares, in 2005 the number of unemployed in Kyzylorda Region was 4.7%, and in 2008 it fell to 3.1%, with a slight increase up to 3.4% in 2018.

In 2005, the number of low-income families receiving targeted state social assistance amounted to 2,510, i.e. 1,059 families (29.7%) fewer than during the same period last year.

The per capita income in Aral District remains the lowest in the region - about 44% of local population live below the poverty line, against the background of official unemployment exceeding 7%. Due to the decline of rural incomes in the Aral Sea Region, the issue of living standards has become the focus of state and public attention (Fig. 11.). In addition, the period of 2005-2015 showed a gradual decrease in the population share (approx. 2%) with incomes below the subsistence minimum.

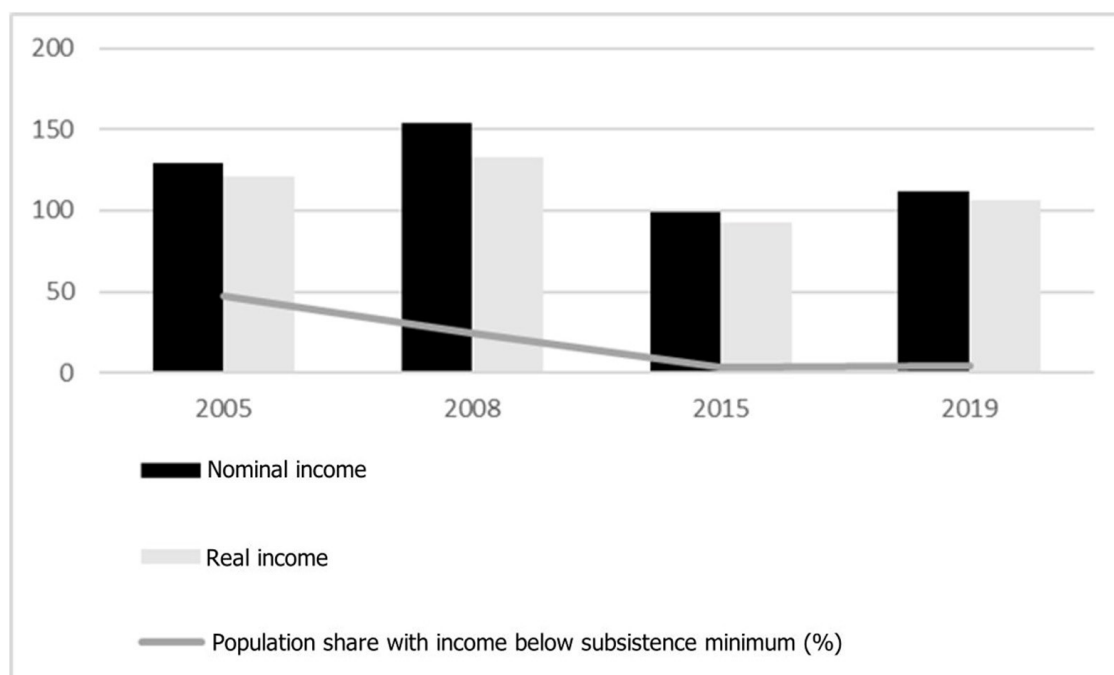


Figure 14. Mean per capita nominal cash income (Tenge) in Aral District of Kyzylorda Region (source: Statistics Department of Kyzylorda Region).

8. Internal migration in Aral District

The analysis of internal migration inside the region showed that the main factor of population outflow from certain communities elsewhere was the resettlement of rural residents to more favorable and promising villages, which is consistent with the global surveys indicating that residents often move to more developed locations due to the consequence of climate change (Nagabhatla et al., 2021). The smallest number of residents left in 2008 (net balance of -3) against the most negative migration balance (-6.8) in 1991. Based on the data of the Statistics Department of Kyzylorda Region, the largest number of immigrating and emigrating persons occurred in 2019 - -41.9 and 36.8 thous., respectively; and the lowest number of immigrating and emigrating residents was observed in 2015 (-9.9 and 6.9 thous., respectively). However, it deserves noting that in the course of the past 5 years the net migration

in Kyzylorda Region has remained stable and amounted to -5.1 in 2019 (Fig. 15.), potentially due to the overall stabilization of the situation in the region, or residents lacking sufficient financial means to migrate, or the traditional power relations not allowing them to leave (Abashin, 2015).

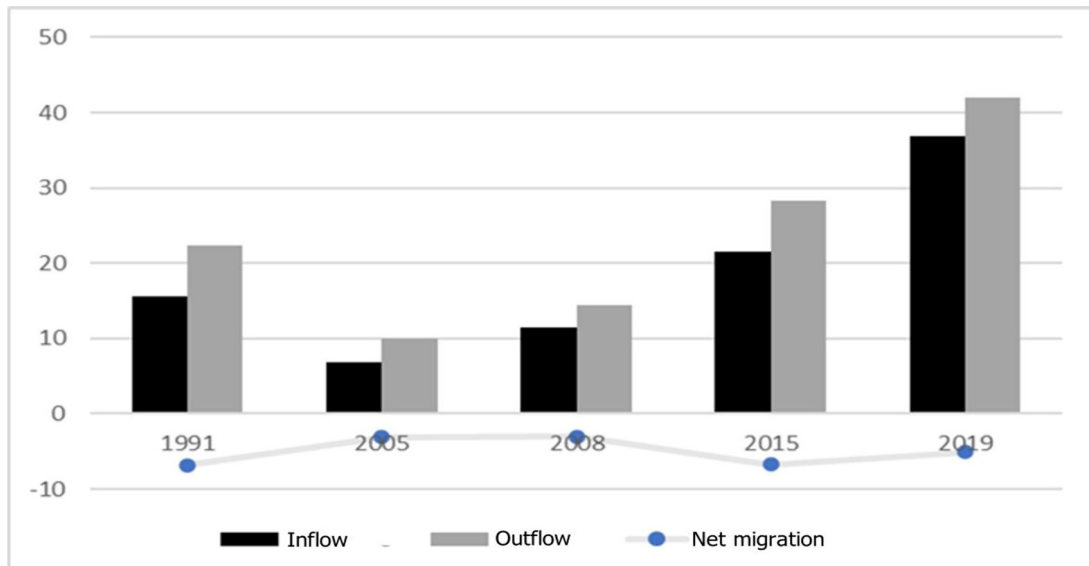


Figure 15. Population migration in Kyzylorda Region (source: Statistics Department of Kyzylorda region).

As for the study area, 2008 witnessed the largest population outflow, with the net migration amounting to -156 (55 persons left the village of Zhaksykylysh). Yet, already in 2015 156 persons arrived in the same village, making the overall district's net migration positive (333 persons).

During 2005-2015, the population in Aral District had remained relatively stable (approx. 15,000 people).

9. Survey results

In total, 120 persons took part in the survey; the gender representation - both aggregated and disaggregated by settlements - was absolutely equal (Table I). Ethnically, all those surveyed were Kazakhs, due to the fact that the overwhelming majority of the population of Aral District and Kyzylorda Region represent the titular nation.

Table I. Respondent gender profile.

Settlement	Male		Female	
	Quantity	%	Quantity	%
Aralsk	19	15.8	19	15.8
Kamystybas	2	1.6	1	0.8
Zhaksykylysh	5	4.1	10	8.3
Kambash Recreation Camp	3	2.5	1	0.8
Kyzylzhar	1	0.8	3	2.5
Karateren	4	3.3	4	3.3
Bogen	1	0.8	2	1.6
Amanotkel	3	2.5	4	3.3
Yeskiura	2	1.6	5	4.1
Shomishkol	1	0.8	-	-
Shomish	1	0.8	4	3.3
Aralkum	4	3.3	2	1.6
Zhanakurylys	4	3.3	5	4.1
Akkulak	4	3.3	2	1.6
Koszhar	4	3.3	-	-
Raim	2	1.6	-	-
TOTAL	60	50	60	50

The survey focused on the age group 18+ years old until the retirement age, i.e. males up to 63 and females up to 58 years old. Married respondents (93 persons) amounted to 80.8% of the surveyed group, with the majority (78%) representing the 18-40 age group (93 of 97 respondents). The distribution allowed drawing the conclusion on family stability in the study area (Table II).

Table II. Respondent marital status profile.

Marital status	18-40 years old		40-60 years old		60+ years old	
	Quantity	%	Quantity	%	Quantity	%
Married	93	78	4	3	0	0
Widow/widower	0	0	1	0.8	3	2.5
Single	11	9.1	5	4.1	0	0

When identifying the number of employed respondents, 77.6% stated that they had a permanent income and workplace; 16% -- not employed or doing other things, for instance, studying; and 2.4% -- engaged in housekeeping.

While assessing the actual financial situation, only 38 respondents replied that “they earned enough for everything except such an expensive item as housing”. When assessing the actual financial standing of households, 19 respondents said that “they had enough money for food, but buying clothes caused serious issues”, and 8 respondents stated that “there was not enough money even for food”. Interestingly, this group of respondents included 10% more females than males, which can be potentially explained by the fact that, due to tradition, women bear all household responsibilities (Table III).

Table III. Assessment of actual financial standing of respondent families.

	Answer	Quantity of respondents	%
1	Not enough money even for food	8	6.7
2	Enough money for food, but buying clothes causes serious issues	19	15.9
3	Buying a TV, refrigerator or washing machine right away would be hard	18	15.12
4	Enough for everything except such an expensive item as housing	38	31.93
5	No financial difficulties, and would be able to buy housing if necessary	15	12.6
6	Refuse to answer	21	17.6
7	TOTAL	119	

In the course of identifying the population group most vulnerable to climate and ecology, it turned out that 40% of respondents considered the elderly (65+ years old) to be the most vulnerable to climatic and environmental conditions in the study area, followed by children under 15 years old (33.6%) - male respondents were mainly answering this way, followed by employed males (14.4%). According to the respondents, adolescents from 15 to 18 years old (6.4%) and females vulnerable to climate and ecology, serves a good indicator reflecting the overall wellbeing in the study area, not only in terms of public health, but also in terms of the economic situation as a marker of welfare.

The assessment of the impact of environmental and climatic factors on the respondents' fitness to work showed the following: approx. 49.6% of respondents did not deny one or another impact of climate and ecology on work life; 42.4% of respondents denied any impact of these factors on work life; and 4% of respondents could not say whether the ecological and/or climatic situation in the region had a direct impact on their work life.

While assessing the satisfaction of the population with the quality of consumed drinking water, 80.8% of the survey respondents stated their satisfaction (according to local residents, the quality of drinking water in Aral District was much higher compared to multiple other areas of Kazakhstan, as it was artesian supplied from deep Sarybulak wells); 9.6% of respondents disagreed expressing their negative opinion regarding the issue; and 5.6% of respondents abstained from replying and described the quality of drinking water neither negatively nor positively.

When determining the degree of satisfaction with the general state of health among the residents of the target settlements in the Aral Sea Region, it was revealed that 56% of respondents had no complaints regarding their general physical condition; 25.6% had certain diseases; and about 15.2% were not aware of their health status. 22.4% of respondents had chronic diseases of different nature and types, about 63.2%

did not have chronic diseases, but did not deny the presence of other mild (non-chronic) diseases, and 9.6% were not aware of whether they had any chronic diseases due to the lack of vivid manifestations and/or alarming symptoms (Table IV).

Table IV. Disease prevalence in respondents.

No	Answer	GIT diseases	Blood diseases	URT diseases	ES diseases
1	Yes	23 (18.4 %)	23 (18.4 %)	11 (8.8 %)	6 (4.8 %)
2	No	80 (64 %)	76 (60.8 %)	80 (64 %)	83 (66.4 %)
3	No answer	16 (12.8 %)	22 (17.6 %)	29 (23.2 %)	30 (24 %)

Over 52.8% of respondents did not deny that to this or that extent ecology (state of the environment) influenced the quality of health of the local population. 32% of respondents did not think that the ecology in the region caused any diseases, and 11.2% of respondents stated that they had never thought about the degree of influence of ecology on human physical condition. 55.2% of respondents did not deny the impact of local climate on the health of local residents, 31.2% thought that the climate had no direct impact on human health, and 9.6% said they had never given it a thought.

Initially, at the time of designing the questionnaire, the quality of water in the Aral Sea remained unknown for the research team, and thus it was important to learn about the perceived impacts of local drinking water on public health. Thus, 57.6% of respondents denied any negative influence of local drinking water on human health, but 25.6% of respondents did not deny it. That could be due to the fact that not all target settlements get their water directly via the central water supply system. In certain villages - remote from the administrative center - water is brought from the local water supply center and stored (for about 1 month depending on consumption rate) in private household wells. Settlement residents clean their personal wells themselves if possible. No one checks the condition of the wells, and the water stays in them losing its proper qualities. 11.2% of respondents abstained from answering the question directly.

It is also worth noting that local residents referred to the fact of adapting to region-specific ecology and climatic conditions. Based on the survey, the majority of respondents (approx. 80%) did not complain about their health and denied having any diseases of the aforementioned systems and/or organs, yet they did not deny the influence of ecology and harsh climate in the region on the health of children and senior citizens. As per the latest reports, in recent years the total mortality has decreased by 4.5%, mortality from blood system diseases - by 47%, and from tuberculosis - by 58.6% (Makhmejanov, 2017).

55% of respondents (66 persons) stated that either they themselves or their family members faced environmental challenges, including the 5 (five) priority ones

related to environmental degradation and climate change: air pollution, drought, strong winds, soil pollution and abnormal heat. 62 of 120 respondents believed that environmental issues in the region had negatively influenced their work life.

The survey respondents referred to children and females as the most vulnerable to environmental degradation and climate change, and to the youth, unemployed, elderly and disabled persons, to a lesser degree.

25.8% of the survey participants (31 persons) noted the fact that local residents emigrated from the Aral Sea Region due to environmental degradation, including 29 respondents that believed that leaving their native places due to deteriorating environment, the migrants moved to other constituencies of Kazakhstan. Among the main environmental causes of population outflow from the study area, the survey respondents named the deteriorating atmospheric air quality, growing frequency of abnormal natural phenomena and natural disasters, as well as poor access to water resources.

Commenting on the overall population migration from the region, 67.5% of respondents (81 persons) stated that over the past 5 years none of their family members and/or friends had changed their place of residence. Meanwhile, the remaining 30.8% (37 persons) indicated that over the same period a member of their family or friend had moved elsewhere. The respondents pointed to the following main reasons for the population outflow from the Aral Sea Region: lack of permanent employment, unsatisfactory remuneration, and lack of occupational work. At least half of all the survey respondents expressed desire to change their location of residence. The other half of respondents did not even consider such a possibility, because they believed that moving would not improve their living standards.

In general, the respondents' answers were positive, evidenced by the fact that 70.4% of the surveyed local residents did not plan to change their place of residence. 23.2% did not deny the possibility of moving to other Kazakhstan's constituencies or abroad in the near future.

10. Discussion

Aral District belongs to the territories most affected by the Aral Sea environmental catastrophe, hence the state's full support of the able-bodied part of the citizenry, providing them with jobs in educational and medical fields, as well as paying 50% extra as an "environmental catastrophe bonus". Moreover, in every possible way - including under the "Back Home with Diploma" Program, adding 25% extra to teacher salaries, and subsidizing housing construction (3 mln Tenge) - the state has been attracting the educated youth to the region. All these led to the fact that the majority of local residents did not express desire to relocate, and helped to

significantly curb the growth of internal migration from Kyzylorda Region. According to the survey participants, the main environmental causes of population outflow from the study area included the deteriorating air quality, augmenting frequency of extraordinary natural phenomena and natural emergencies, as well as decreased access to water resources.

Health condition represents one of the welfare indicators overall in the region, and the degree of people's satisfaction with their life quality. Despite the fact that the data indicated the satisfactory health status of the population of Aral District, the survey respondents did not deny the influence of environment on human health.

Based on the impressions of local residents expressed during the survey, the quality of drinking water from the Sarybulak Well corresponded to the "artesian" grade, i.e. such "water does not harm human health, but, on the contrary, saturates the body with useful substances and strengthens health overall". However, the issue of water storage in the settlements remote from the administrative center - where the water supply system is not connected to individual households - remains open. It is also important to emphasize that local residents noted the fact of adaptation to the ecological and climatic conditions in the region. As per the survey findings, the majority of respondents (approx. 80%) did not complain about their health and denied suffering from any disorders of the aforementioned systems and/or body organs, yet they did not deny entirely the fact that the environment and harsh climate (present in the region) influenced the health of children and the elderly. According to the available data, in recent years the total mortality has dropped by 4.5%, mortality from blood system disorders - by 47%, and from tuberculosis - by 58.6% (Makhmejanov, 2017).

As a demographic parameter, child mortality is considered an indicator of environmental welfare and overall public health. As noted earlier, inside Kazakhstan Kyzylorda Region is leading in terms of child mortality (0-5 years old), with the main causes being the URT diseases, followed by anemia, and gastrointestinal tract disorders - i.e. the damaging effects of the region's ecology and climate on infants are rather obvious. The state of the environment, dry climate, lack of nutrients obtained with mother's milk, the environment in which mothers and children live - all these and multiple other factors combined adversely affect the condition of babies in the Aral Sea Region. Yet, the most recent demographic and health indicators for children (0-5 years old) mortality, i.e. the 47% fall, are self-explanatory.

The situation in the Aral Sea Region has been slowly but significantly stabilizing - the respondents did not complain about the state of their health, permanent employment, additional payments from the state, etc. The surveyed local residents also stated that they did not want to relocate - 70.4% of respondents did not plan to move elsewhere in the next 5 years. It is safe to say that the Aral

Sea Region's environment and climate do influence human health, but the situation has been following a stabilizing trend, and people have been adapting to the ongoing environmental challenges. Thus, the environmental health impacts cannot be deemed contributing to population outflow to other Kazakhstan's constituencies and/or countries.

In the course of the field mission, the authors faced several challenges, including related to the coronavirus pandemic. The excessively high morbidity and mortality in humans was still fresh in the respondents' memory and influenced their answers. Subject to all sanitary restrictions/ requirements, the authors attempted to conduct two in-depth interviews.

Another challenge worth mentioning was a certain level of distrust on behalf of local residents towards the research team. Since the Aral Sea Region is rather popular among scholars, some residents were afraid to fill out the questionnaires even anonymously.

One of the members of the research team suggested that some respondents were, perhaps, not fully honest when filling out the questionnaires, potentially due to the strength of the traditional way of life and customs among the local population, i.e. silencing unpleasant facts based on the principles of "not washing dirty linen in public" and "letting every man praise the bridge he goes over".

11. Conclusion

The shallowing of the Aral Sea has definitely brought about a number of social and economic changes and affected the health status of local residents. The study allowed analyzing the region-specific impact trends of the environment and climatic conditions on the life of local population in the course of the last 14 years, as well as harvesting valuable information via survey.

Built in 2005, the Kokaral Dam generated multiple positive effects, including the return of fish to local water bodies and revival of local fisheries. The literature review allowed revealing that until 2005 the situation in the Aral Sea Region was rather baffling. Accordingly, the need arose to collect the data required to refine these of the Statistics Committee of the RK, as well as to establish the real impact of climate change on the socio-economic situation, and public health.

The region's social and economic indicators remained stable throughout the study duration, with some unemployment still present and mainly affecting women, which corresponded to the established traditional societal setting in the region. A certain level of social "archaism" coupled with the Batyr-Ana Program (aimed at maintaining the birth rate) have yielded the high birth rates in families. This fact was established based on observations and directly during the survey. A fairly high

birth rate ensures stable population endowment.

In terms of public health - specifically with respect to the incidence of diseases caused by unsatisfactory environmental condition (blood system disorders, upper respiratory tract issues, metabolic and endocrine disorders, and digestive system diseases) - the official statistics indicate certain issues with their prevalence in local population. However, the past 14 years showed a stable decrease in the number of registered cases, potentially due to the overall development of local healthcare system, gradual stabilization of the environment (afforestation, restoration of the water level in the Small Aral Sea), addressing water supply challenges, and other factors.

The initial hypothesis of the study - that population outflow was taking place due to the environmental changes in the target area adversely affecting the state of public health - was disproved by the survey findings, as local residents mainly associated migration with the need to get higher education, occupational employment opportunities in other constituencies, and better living standards in other settlements.

Thus, it can be concluded that thanks to the construction of the Kokaral Dam over the last 14 years the situation in the Aral Sea Region has started to stabilize, with several positive ongoing processes, i.e. water approaching the town of Aral'sk, and overall sea water level raising. Saxaul plantations help fixing dust lifted from the dried sea bottom by strong winds. Thanks to the "100 schools, 100 hospitals" Program implemented in Aral District, its residents now enjoy the opportunities of getting primary and secondary education, as well as qualified first aid. The compensations paid by the state ensure access to better medical services; the drinking water consumed is not hazardous and does not threaten human life and/or health - this fact was confirmed by the survey and water chemical composition analysis data provided by local authorities.

Local residents did not complain about the dry climate or poor ecology in the region, arguing that they did not affect their livelihoods in any way. In addition, the interview pointed to a significant level of adaptation to environmental conditions among local residents.

The study results may serve basis for further research of the social and economic development of the region, including these focusing on other aspects of the life of Aral Sea Region population.

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