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THE CURRENT STATE OF THE QUALITY OF NATURAL WATERS OF THE SOUTHERN ARAL SEA

Doctor of Agricultural Sciences **prof. A.Jumamuratov,**
Doctor of Biological Sciences **doc. M.A.Jumamuratov**
Nukus State Pedagogical Institute named after Ajiniyaz

Annotation. The article considers the results of the study of natural waters of the Southern Aral Sea. Based on the study of the analyzed natural water, the great potential of the neutron activation analysis technique is shown. The technique was used in the analysis of near waters of Karakalpakstan. For analysis, samples of river, ditch, lake, collector-drainage, and underground waters of the region were collected.

Keywords: *Southern Aral Sea, soil, natural water, neutron-activation analysis, chemical content.*

INTRODUCTION

In the world, the processes of soil degradation, global climate change, desertification and urbanization, anthropogenic and technogenic impacts on the natural environment lead to increased environmental pollution with various pollutants. International and national environmental programs, the introduction of effective resource-saving innovative technologies, as well as other measures are still not sufficient to reduce the rate of degradation of the natural environment.

The study of the quality of natural waters (surface, underground, drinking, irrigation waters, etc.) and the processes of salinization and pollution associated with water, waterlogging of fertile soils with heavy metals, agrochemicals, their impact on public health are among the priority tasks in the field of ecology and protection environment, in particular for the South Aral Sea region [1]. In the conditions of the anthropogenic ecological crisis, the nature, quantity and content of chemical elements change in space and time, as well as in relationship with individual components of the natural environment (soils, plants, water, air, etc.). The study of any individual component does not give practically positive results. In this regard, we tried to study the elemental composition of natural waters (river, ditch, canal, water supply, drainage-collector, etc.), as well as some other objects of the natural environment, which have not yet been studied enough in the South Aral Sea region.

METHODOLOGY AND OBJECTS OF RESEARCH

The current negative ecological situation of the South Aral Sea zone has, in ecological terms, some territorial differentiation of various scales, which is reflected in the works [2]. According to the developed classification and distribution of the Southern Aral Sea region into three zones (I - catastrophic, II –critical, III - relatively-critical), we laid the basis for planning the selection of the study area and sampling points. We consider the division of zones into "subzones" unnecessary, since ecological and geochemical processes, by nature and orientation, can be more or less large-scale (fig.1).

Fig. 1. Map-scheme of sampling of natural environments:

Note: northern regions - Muynak, Kungrad, central regions - Shumanai, Nukus regions, southern regions - Turtkul, Ellikkala.

Within each ecosystem, the patterns of accumulation and distribution of individual chemical elements can occur in conjunction with internal and external factors.[2]. In carrying out this work, we also focused on an integrated approach, namely, based on the analysis of the interrelationships of individual components of the biosphere, we investigated the patterns of distribution and accumulation of a wide range of chemical elements in areas of extreme environmental disaster, and, at some distance from it, by sampling in all economic areas from north to south.

When zoning the territory of the Southern Aral Sea region, the nature of the processes of desertification, salt formation and soil salinization were taken into account. Since the task of our research was to study the main agricultural landscapes of the Aral Sea region, when sampling, we focused on the study of the elemental composition of the arable soil layer and the composition of some environmental objects that can affect the ecological state of the soil cover to one degree or another.

The objects of study were soils, natural waters (river, ditches, collector-drainage, water supply, ground), plants (wild plants, cotton and its individual organs, grain), mineral fertilizers, atmospheric precipitation, aerosols of the surface layer, rocks and minerals, selected in Karakalpakstan.

To determine a wide range of chemical elements, the irradiation of the analyzed samples was carried out in the thermal and horizontal channels of the WWR-SM nuclear reactor at the Institute of Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan. The induced activity of irradiated samples was measured on a γ-spectrometer consisting of a Ge(Li) detector with a resolution of 4.5 keV along the 1332 keV (60Co) γ-line and a personal computer using the Aspect program, as well as a Ge detector with energy with a resolution of 1.8 keV and the Genny-2000 program.

RESULTS AND DISCUSSION

Currently, the problem of preserving, protecting and improving the quality of natural waters in the region is becoming a priority. The quality of natural waters is largely related to the degree of mineralization of waters, therefore, the study of this issue is an integral part of the elemental analysis [3]. The results showed that the mineralization of natural waters in the Southern Aral Sea region varies in a wide concentration range (95.6-216.4 mg/l) [4]. As the research results show, the minimum mineralization index was noted in the tap water of the city of Nukus, and the maximum - in the underground water of the city of Khalkabad (Fig. 1).

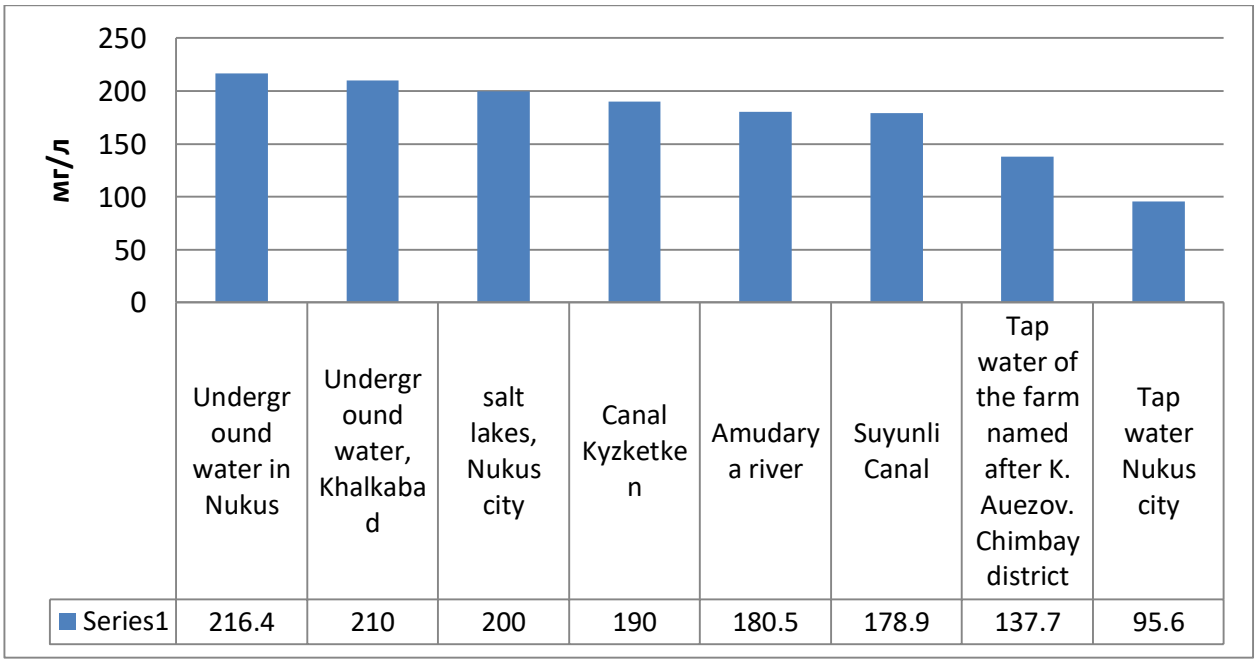
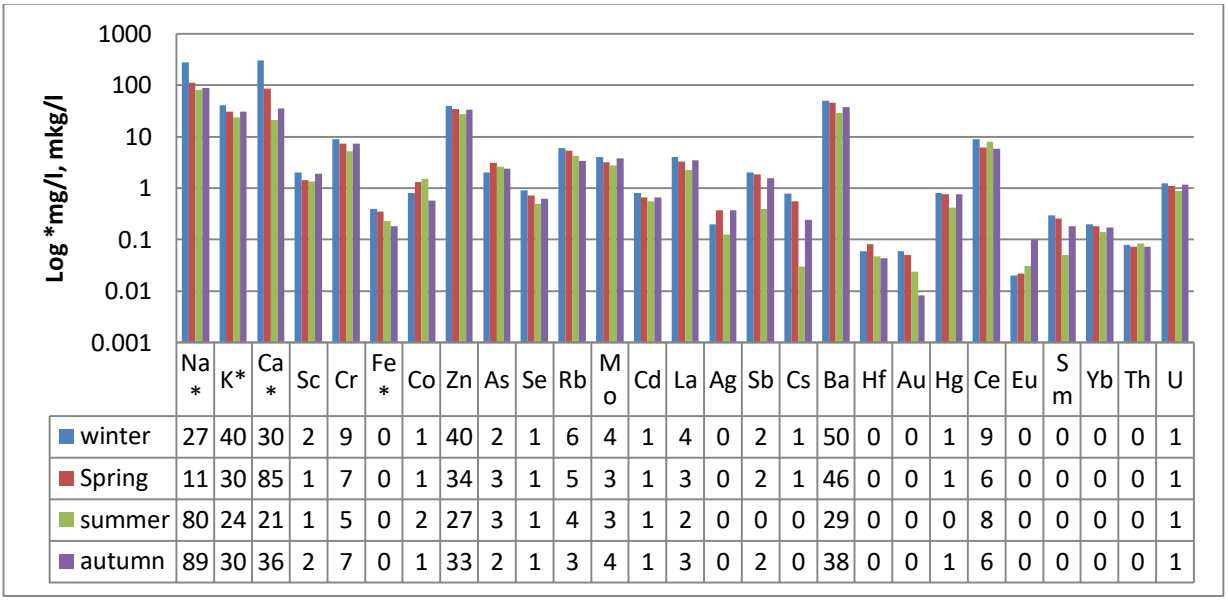


Fig.1. The degree of mineralization of waters in the Southern Aral Sea region (2012-2020)

Natural waters are the most dynamic, erosional and anthropogenic processes that occur in the landscape, where river runoff is formed, significantly change the elemental composition of water. These processes, combined with the geomorphological characteristics of the region, make it possible to assess the distribution of individual chemical elements in the waters of the river Amudarya (Fig.2.). The obtained results show that in winter the waters of the river. The Amu Darya is contaminated with almost all elements of the periodic table. Water pollution in winter is due to the fact that flushing and irrigation waters coming from highly saline soils are washed off and discharged into collectors, and then into

the river. Amu Darya. These so-called return waters in the region form up to 40-45 km3, half of this volume is discharged into rivers, deteriorating the quality of irrigation and drinking water in the region. [5,6,7].



	Na*	K*	Ca*	Sc	Cr	Fe*	Co	Zn	As	Se	Rb	Mo	Cd	La	Ag	Sb	Cs	Ba	Hf	Au	Hg	Ce	Eu	Sm	Yb	Th	U
winter	27	40	30	2	9	0	1	40	2	1	6	4	1	4	0	2	1	50	0	0	1	9	0	0	0	0	1
Spring	11	30	85	1	7	0	1	34	3	1	5	3	1	3	0	2	1	46	0	0	1	6	0	0	0	0	1
summer	80	24	21	1	5	0	2	27	3	1	4	3	1	2	0	0	0	29	0	0	0	8	0	0	0	0	1
autumn	89	30	36	2	7	0	1	33	2	1	3	4	1	3	0	2	0	38	0	0	1	6	0	0	0	0	1

Fig. 2. Seasonal changes in the content of chemical elements in the water of the Amudarya river in the territory of the Southern Aral Sea region (mcg/l, *mg/l)

It is known that land reclamation works traditionally begin to be carried out in the spring season. According to experts, collector-drainage waters contain a residual amount of agrochemicals, mineral salts, trace elements removed from irrigated areas, and poorly treated municipal and industrial effluents are also discharged into them. [8].

In the river water in winter, as a result of the discharge of return waters and the feeding of the surface watercourse by groundwater, the content of Na, K and Ca reaches maximum values, and in the summer it normalizes and, starting from autumn, the high content of these elements again rises. [9]. As noted above, as a result of discharge from the fields of Uzbekistan and Turkmenistan of drainage-collector and technical waters, the mineralization of water has sharply increased, especially in the lower reaches, reaching 10.0 g/l [10].

A whole spectrum of various pesticides used for agriculture has been found in the composition of waters [93, p. 75; 98, p. 36-38]. Below we will consider seasonal fluctuations in the content of individual chemical elements in the waters of the Amudarya River.

Anthropogenic atmospheric pollution can be characterized by the duration of their presence in the atmosphere, by the rate of increase in their content, by the scale of influence, by the nature of the influence. The analysis of actual data on atmospheric air pollution in the territory of the Republic of Karakalpakstan showed that the proportion of atmospheric air samples exceeding the MPC of pollutants ranged from 18.2% to 7.2% depending on time (by years) (fig.3.). The ranking of the degree of atmospheric air pollution in various regions of Karakalpakstan showed that in the Northern regions there is an increase in dust concentration over all the surveyed years, the amount of the average monthly dust concentration ranged from 0.2 to 0.6 mg/m3 with a maximum permissible concentration of 0.15 mg/m3. It was found that in the central and southern regions of the Republic of Kazakhstan in the atmospheric air concentrations of carbon monoxide they reached up to 4 mg/m3 (MPC - 2 mg/m3), nitrogen dioxide ranged from 0.03 mg/m3 to 0.05 mg/m3, the maximum single concentration was 0.09 mg/3 (MPC - 0.04 mg/m3).

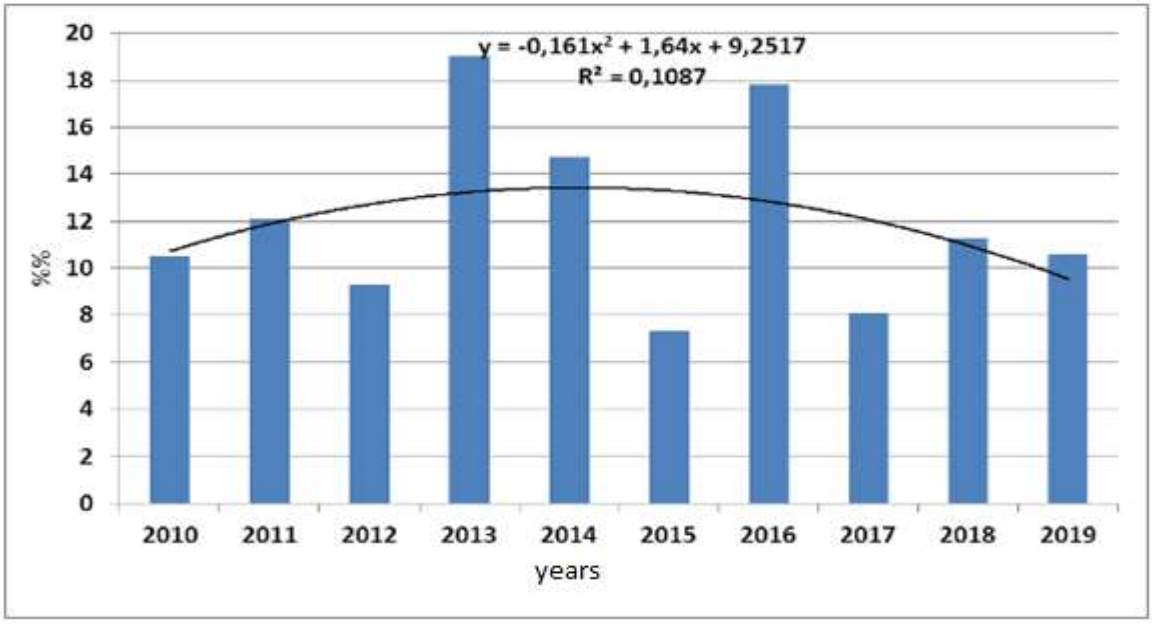
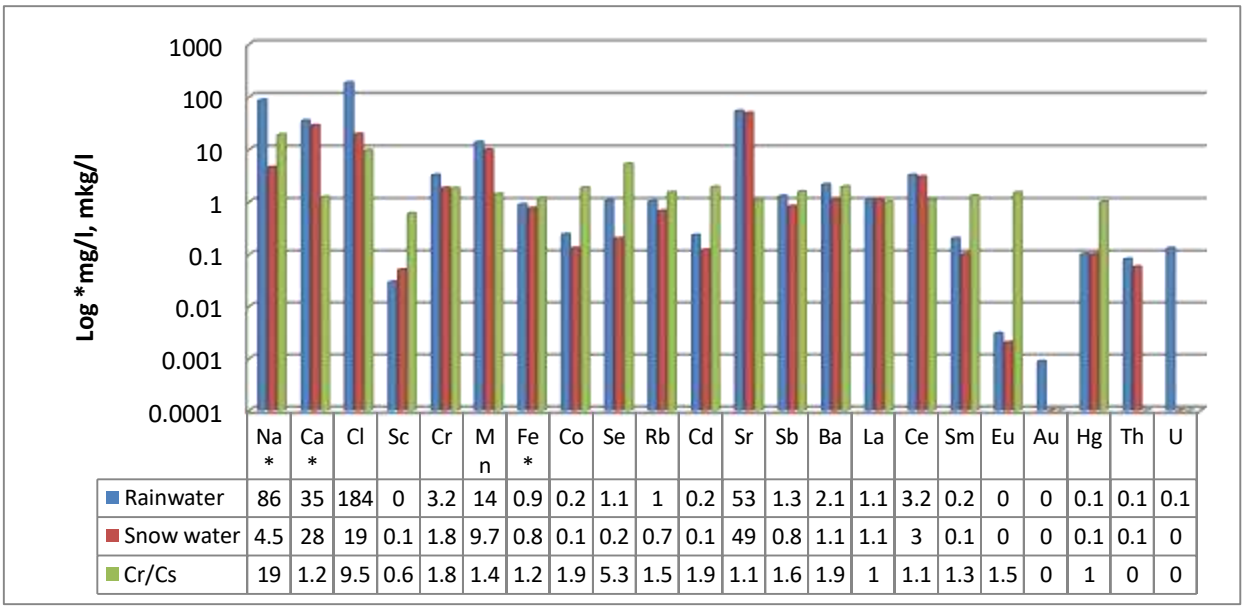


Fig.2. Dynamics of the specific gravity of atmospheric air samples exceeding the MPC of pollutants (%) for 2010-2019.

At the same time, a comprehensive study of the elemental composition of atmospheric precipitation and dust in the surface layer is an urgent task for assessing the scale and direction of dust and salt pollution occurring in the South Aral Sea region. The results of the analysis show that rainwater is significantly enriched with chemical elements (Fig. 3).



	Na *	Ca *	Cl	Sc	Cr	Mn	Fe *	Co	Se	Rb	Cd	Sr	Sb	Ba	La	Ce	Sm	Eu	Au	Hg	Th	U
Rainwater	86	35	184	0	3.2	14	0.9	0.2	1.1	1	0.2	53	1.3	2.1	1.1	3.2	0.2	0	0	0.1	0.1	0.1
Snow water	4.5	28	19	0.1	1.8	9.7	0.8	0.1	0.2	0.7	0.1	49	0.8	1.1	1.1	3	0.1	0	0	0.1	0.1	0
Cr/Cs	19	1.2	9.5	0.6	1.8	1.4	1.2	1.9	5.3	1.5	1.9	1.1	1.6	1.9	1	1.1	1.3	1.5	0	1	0	0

Fig. 3. Elemental composition of rain and snow waters sampled in the suburban territory of Nukus (mcg/l, *mg/l)

The study region can be attributed to a biogeochemical province with an excess of Na and Cl, especially the northern part of the study region. According to the degree of pollution of rainwater, after Na and Cl there are such elements as Se (Cd / Cc = 5.25), Ba (Cд / Cc = 1.94), Cd (Cд / Cc = 1.91), Co (Cд /Cc=1.85), Cr (Cd/Cc=1.8), Sb (Cd/Cc=1.56), Rb (Cd/Cc=1.52), Eu (Cd/Cc=1.50), Mn (Cd / Cc = 1.45), Th (Cd / Cc = 1.40), Sm (Cd / Cc = 1.30), Ca (Cd / Cc = 1.23), Fe (Cd / Cc = 1.18), Sr (Sd/Ss=1.08), etc.

The water supply of various districts of Karakalpakstan is based on surface and underground waters of the Amu Darya River basin. The quality of surface waters also deteriorates significantly due to the return to the river from irrigated lands of waters with increased mineralization contaminated with pesticides, inorganic fertilizers, as well as discharges of untreated and insufficiently treated industrial and household effluents from the upper and middle reaches of the Amu Darya River. Therefore, the quality of drinking water largely does not meet the standards (Fig.4).

The linear trend shows a decrease in the proportion of non-standard samples of tap water in terms of chemical parameters. The linear trend of indicators of non-standard samples of tap water in terms of bacteriological indicators shows a certain stability of indicators of pollutants.

In water pipelines supplying water from surface sources, the percentage of water quality deviations in some years reached from 18% to 44% in terms of chemical indicators.

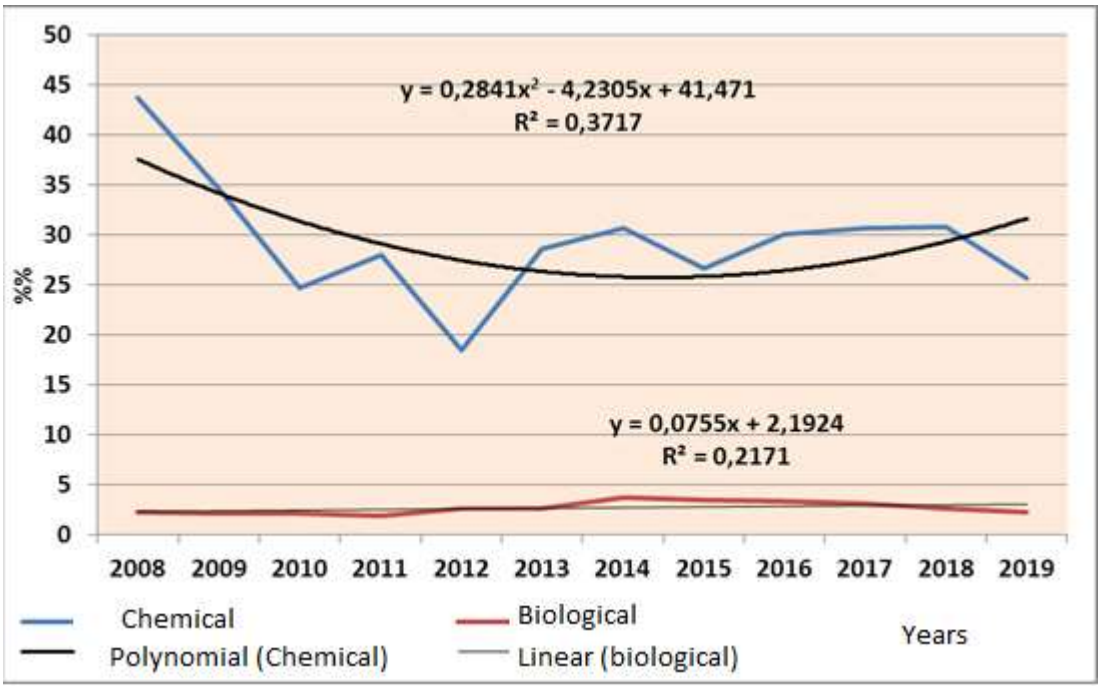


Fig. 4. Dynamics of indicators of non-standard samples of tap water in the Republic of Karakalpakstan (%)

Thus, based on the study of the degree of mineralization, the elemental composition of river, drainage-collector, canal, underground and tap waters, as well as atmospheric dust and precipitation and monitoring the background level of chemical elements of river water, it was established that the main pollutants of the natural waters of the region are such elements, as Na, Cl, Ca, Cr, Co, Fe, Cu, Zn, Se, Br, Cd, Ba, La, Ce, Au.

We explain the water pollution during the transition to the channel bed by the fact that due to the rise of the groundwater level, individual compounds of chemical elements in soils often dissolve, depending on the pH of the soils and the contacting waters, which enrich the composition of the channel waters.

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