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THE NEGATIVE IMPACT OF ANTHROPOGENIC FACTORS ON THE STATE OF GROUNDWATER OF KAZAKHSTAN

Abstract. This article reviews the negative impact of anthropogenic changes on groundwater.

The main changes in physical and geographical conditions that occur under the impact of anthropogenic pressures and that have the most significant influence on the state of groundwater, as well as a negative impaction the conditions of the formation of groundwater are: changes in the landscape caused by agricultural works, mining, construction of settlements, etc.; changes in the hydrographic network caused the construction of hydroelectric power facilities; changes in the composition of the atmospheric air; changes in the groundwater level regime, climatic conditions. The most significant factor of change in groundwater formation conditions is the progressive anthropogenic pollution of groundwater. It negatively influences the number of resources and their quality.

Key words: Groundwater, anthropogenic changes, groundwater pollution.

Introduction. The features of climatic conditions have left their mark on the formation of the river network. The increasing anthropogenic impact on the environment results in quantitative and qualitative changes in the state of the environment, including changes in hydrogeological parameters of aquifers and aquifer systems.

Water resources of Kazakhstan have decreased by 20 km^3 per year over the past 50 years, and this process is going on. The decrease in water volumes is associated with global and regional climate changes, and most of all with increased water withdrawal from both groundwater resources and from transboundary rivers in neighboring countries. Large rivers flowing through our country's territory originate in neighboring countries. This led to the problems in the rational use of transit rivers and their ecological state.

The most significant factor that causes changes in the state of groundwater is progressive anthropogenic pollution. It does not directly affect the volume of resources but, in some cases, reduces the volume of available groundwater resources because water quality characteristics do not comply with sanitary norms [1,2]. For example, during exploitation of the Almaty groundwater deposit in the city of Almaty, as a result of pollution, aquifers lying at a depth of less than 150 m, according to the requirements of sanitary and epidemiological authorities, can only be used for technical purposes and are not suitable for drinking water supply.

Groundwater deposits in the city of Astana are not exploited due to progressive pollution [3]. In the Republic of Kazakhstan, there is groundwater pollution in Aktobe, Akmola, Almaty, East Kazakhstan, South Kazakhstan regions. It causes restriction of use and, consequently, reduction of operational groundwater reserves.

It was established that the biggest changes in the state of groundwater caused by anthropogenic factors occur in the industrial centers, urban agglomerations and in the ecological disaster zones in the Aral Sea region and at the Semipalatinsk nuclear test site.

Methods. A comprehensive analysis of hydrogeological materials on the territory of Kazakhstan was used as a research methodology to determine the negative impact of anthropogenic factors on the state of groundwater.

Anthropogenic impact on landscapes. The diversity of geological-geomorphological, climatic, soil and vegetation conditions of the territory of Kazakhstan determines the diversity of landscapes. As solar heat increases from the north to the south and precipitation decreases, there is a consecutive change of natural zones: forest-steppes, steppes, semi-deserts and deserts.

Technogenic impact on landscapes of Kazakhstan is quite significant. The change of landscapes results in overwetting of lands, swamping, oppression of natural vegetation and its replacement by hydromorphic species. The share of landscape areas in terms of the degree of anthropogenic impact is as follows: the areas of medium and strong disturbance are approximately equal and reach 42% in total; the areas of light disturbance make up 38%; the areas of very light and insignificant anthropogenic impact make up 20%.

According to the land balance data, as of November 1, 2017, there were 247.7 thousand hectares of disturbed lands in the Republic of Kazakhstan. There are quarries, overburden rocks and mining dumps, tailing dumps, ash dumps, oil fields and barns on these lands. In all industrial regions there are ecologically dangerous zones that have a negative impact: spoil tips, dumps, quarries, drilling wells, wastes of mining production; they occupy a total area of more than 60 thousand hectares and constantly pollute the soil [4].

Diverse anthropogenic impact on nature leads to significant changes in the natural zones. Agricultural production has the most significant impact on the natural territorial complexes of Kazakhstan. 85.3% of the land of the country is used for agricultural production; it significantly affects the landscape and ecological status of the land. An agrogenic impact, impact of reclamation and impact of pasture are the main agricultural impacts on landscapes. Steppe landscapes disappear; indigenous forest landscapes are replaced by derivatives; swamps are drained; deserts are irrigated, etc.

Change in natural hydrogeological conditions. An anthropogenic impact on groundwater has become particularly significant in this century due to the development and intensification of industry and agriculture, the growth of large cities and the expansion of urbanized areas. It manifests itself in the depletion of groundwater resources and deterioration of their quality.

The anthropogenic intervention in the natural groundwater regime has a significant impact on ecosystems. Intensifying anthropogenic pressure on groundwater resource potential leads to progressive deterioration of ecological and hydrogeological conditions in Kazakhstan. This is primarily associated with the depletion of groundwater resources, formation of cones of depression and water afflux zones, groundwater pollution, which significantly impacts the environment (including the geological environment) and human habitats. These negative changes happen with the most intensity in the areas of development of mining, oil and gas production and chemical industry [2,5].

Significant changes in natural hydrogeological conditions occur when groundwater is exploited for water supply, irrigation, watering of pastures. Aquifers are depleted, i.e. overlying and adjacent aquifers' groundwater reserves are exhausted; extensive cones of depression occur; hydrogeological conditions in oil and gas aquifers change during the development with maintenance of reservoir pressure, which contributes to the penetration of aggressive oil and gas fluids into the upper aquifers; groundwater and surface water are polluted; chemical composition of groundwater changes [11].Thus, at the oil fields of the Yuzhno-Embinsky oil and gas production complex, about 18-20 million m^3 of produced water is extracted in the process; only about 30% of it is re-injected into the oil-bearing formations to maintain reservoir pressure; the remaining water is discharged into the nearby salinas.

Hydrogeological conditions significantly change on the irrigated lands: water and salt balance of the irrigated zone changes; there is an increase of groundwater level; groundwater is polluted with toxic fertilizers and chemicals, i.e. their hydrochemical regime changes; there is (widespread) soil salinization, which is the main scourge of irrigated agriculture and one of the important negative factors of impact on the geological environment.

Influence of groundwater exploitation for various purposes (water supply, irrigation, watering of pastures, etc.). Great changes in natural hydrogeological conditions of a particular area occur under the influence of groundwater exploitation for water supply, land irrigation and, considerably on a smaller scale, for watering of pastures.

All the negative processes manifested themselves particularly strongly at large exploited groundwater deposits used for the water supply of Almaty, Taraz, Shymkent, Kentau, Ust-Kamenogorsk, Semey, Kyzylorda, Baykonyr, Zhezkazgan and other cities (table 1) [6].

Table1 –Formation of cones of depression in the areas of large water intakes

Administrative regions	Settlements, districts	The maximum decrease in the groundwater level, m	The cone of depression's area, km^2
West Kazakhstan			
Aktobe	Aktobe city Khromtau town Oil fields	25-30 20-25 120-170	40-45 30-35 7,000-9,000
Atyrau	Oilfields	130-200	22,000-24,000
West-Kazakhstan	Uralsk city Oil fields	30-35 100-150	35-40 5,000-6,000
Mangistau	Oil fields	130-190	10,000-12,000
North Kazakhstan			
Kostanay	Kostanay city	25-35	25-30
North-Kazakhstan	Petropavlovsk city	15-20	15-20
Akmola	Kokshetau city	15-20	20-25
Pavlodar	Pavlodar city	15-20 50-60	15-20 70-80
Central Kazakhstan			
Karaganda	Karaganda city Zhezkazgan city Baikonyr city Shakhtinsk town Temirtau city Balkhash city	60-120 80-130 40-60 50-100 50-100 40-90	80-200 80-250 50-70 70-110 70-110 50-90
East Kazakhstan			
East-Kazakhstan	Ust-Kamenogorsk city Semey city	35-60 15-20 30-50	30-40 25-30 35-40
South Kazakhstan			
Almaty	Taldykorgan city Almaty city Talgar town Ushtobe town Dostyk railway station	20-25 20-40 70-80 30-35 30-40	30-40 140-150 140-150 40-50 60-70
Zhambyl	Taraz city Karatau town	65-70 80-100	>100 60-65
Turkestan	Turkestan city Shymkent city Kentau town	10-15 25-30 550	15-20 110-120 >1500
Kyzylorda	Kyzylorda city, East Sub-Aral area Oil fields	40-45 130-150	>90 >25,000 3,000-5,000

Cones of depression with the area of 140-150 km^2 each occurred at the exploited Almaty and Talgar groundwater deposits (an alluvial fan).

A typical example of the influence of drainage of mine workings during long-term exploitation of solid mineral deposits is the Mirgalimsayskoye polymetallic deposit, which is karst carbonate rocks of the Karatau mountain range. For the 25-year period of industrial development of the deposit area, the total reduction of the level of fissure-karst water in the center of the minefield reached 550 m and a huge cone of depression with the area of more than 1500 km^2 occurred. The processes of intensive drainage of water-bearing limestone and drainage of the territory not only led to a radical change of the conditions for the formation of the regime of fissure-karst water but also caused a significant violation of the natural regime of almost all types of groundwater which are common in the deposit area.

Fluctuations of groundwater levels. Another type of anthropogenesis of the natural groundwater regime is the increase of its levels which is accompanied by flooding of various structures and which spreads on the larger area [7]. About 300 settlements in Kazakhstan are periodically hit by flooding to some extent. Among them, there are such large cities as Nur-Sultan, Almaty, Karaganda, Kokshetau, Atbasar, Shchuchinsk, Pavlodar, Atyrau and others[1,5,8,9].

1. Areas that are drained and heavily drained with terrain fragmentation of >50 m and prevailing groundwater depth of more than 3-5 m, less frequently 10 m. These territories occupy 15-20% of the area of the Republic of Kazakhstan and are located mainly in the Central Kazakhstan Uplands, the Mugodzhar Hillsand mountain systems of the orogenic belt of Eastern and South-Eastern Kazakhstan.

2. The edges of the main river basins of Kazakhstan represented by deltaic strata, floodplains of river valleys, numerous lake systems and water reservoirs are the complete opposite of intensively drained mountain and lowland areas. These areas are periodically flooded by river water during high water and flood periods. The groundwater depth is less than 2 m during most of the year. The drainage of these areas is extremely low - the depth of terrain fragmentation is usually less than 5 m.

3. Weakly and medium-drained areas with terrain fragmentation of <50 m and with groundwater depth of 3-5 m have an intermediary position. Geomorphologically, these areas belong to the southwestern part of the Caspian Plain - its sandy plains, the Ural-Emba denudation plateau, the central part of the Mangistau Plain, the Karatau mountain range and the most part of the Mugodzhar area's uplands, the southern part of the Torgay table plain and the northern part of Aral Sea region, the eastern part of the Aral structural-denudation-accumulative plain, the denudation plain of the Kazakh Uplands, the northern and southern parts of the Shu-Sarysu denudation-accumulative plain; the western, southern and eastern parts of the Syrdarya accumulative plain and the most part of the Balkhash-Alakol Plain.

From the anthropocentric point of view, it is necessary to identify degrees of territorial disturbance of landscapes, ecosystems and their corresponding zones [10,11]:

- environmental well-being; in this case, the state of natural complexes is close to their natural functioning, ensuring traditional forms of economic activity without damage to the health of the population; these are lands of the first category;
- environmental risk; in this case, there is a fixed change in the natural properties of natural complexes which leads to negative consequences for nature and people; these are lands of the third category;
- environmental crisis; in this case, the change in the properties of natural complexes poses a threat to economic activity and people's health;
- environmental disaster; in this case, negative changes of natural complexes lead to disruption of the existing economic activity; to a significant increase in human morbidity; a serious system of measures is required to eliminate the damage;
- environmental catastrophe; in this case, negative changes of natural complexes lead to the impossibility to conduct traditional economic activity and human habitation; a vivid example is the environmental catastrophe of the Aral Sea which passed consistently through the environmental crisis and environmental disaster.

Anthropogenic pollution of groundwater. Groundwater in Kazakhstan experiences various hydrogeological conditions and suffer from severe anthropogenic impact. It is primarily manifested in the pollution of groundwater. The main sources of groundwater pollution are industrial wastes of mining complexes and oil and gas production complexes, agricultural facilities, cities and large settlements, large dumps of industrial, household and radioactive wastes, etc. The largest polluted sites are located near enterprises that discharge industrial wastes and sewage to the earth's surface or into the river network without preliminary treatment. In 2016 the total volume of sewage discharged into the river network was 5.9 km^3/year, including 0.131 km^3/year (2.25%) of untreated sewage [4]. Such facilities include the majority of enterprises of mining, processing, construction, livestock and transport industries, as well as urban agglomerations with an unreliable industrial and household sewage treatment system or without any system. For example, some water intakes used for domestic purposes in the cities of Aktobe, Temirtau, Karaganda, Shemonaikha and Ridder (Leninogorsk). Mining and industrial enterprises of Karaganda, East Kazakhstan and Aktobe regions have the greatest impact on groundwater.

In recent years, the number of identified and potential sources of pollution has remained almost unchanged. The reasons include the economic downturn in the country, the decrease in the growth of

industrial and agricultural production and the associated decrease in the volume of pollutants and in the volume of wastewater. At the same time, there is an increase in the pollution level of water bodies by the number of ingredients, which is probably due to an increase in the inflow of scattered pollution sources into water bodies with surface runoff caused by the lack of systematic, targeted work to eliminate such pollution sources. Intensive development of mining and processing of minerals resulted in the fact that the basis of modern industry in the country is formed by the most environmentally hazardous enterprises in metallurgy, fuel and energy and mining industries. They make up 88.5% of all emissions to the environment. In Kazakhstan, the largest sites of polluted groundwater are within the Karaganda, Pavlodar-Yekibastuz, Rudno-Altyi, Kostanay and Karatau (South Kazakhstan) mining complexes, as well as in Almaty and Semipalatinsk regions.

Based on the results of the monitoring, in the area of large cities, the sites with polluted groundwater were discovered in the zone of influence of individual water intakes. Large sites with polluted groundwater are located near these water intakes, which leads to a failure of entire groundwater intakes or their sections. Withdrawal of water for domestic purposes is stopped at the sites with polluted groundwater of Aktobe, Ust-Kamenogorsk and Karaganda cities.

The main criteria of natural water's quality by hydrochemical indicators are values of Maximum Permissible Concentrations (MPC) of pollutants. It is valid for water sources used for domestic purposes, for utilities and for the fishing industry.

According to the data of the Groundwater Monitoring Service, more than 1100 potential sources of groundwater pollution are detected on the territory of the Republic of Kazakhstan. 350 of them directly impact the hydrogeochemical state of groundwater. The greatest number of sources of pollution were found in Pavlodar region (255 sources), Karaganda region (210), East Kazakhstan region (117), Akmola region (103) and Almaty region (103) (table 2). These are the most environmentally unfavorable regions of Kazakhstan in terms of pollution levels. One should consider the ecological status of groundwater in the administrative regions of Kazakhstan [6].

Table2 – Distribution of sources and sites of groundwater pollution by the administrative regions of the Republic of Kazakhstan and the availability of the monitoring network as of January 1, 2016

Administrative region	Number of potential sources of groundwater pollution	Number of detected sites with groundwater pollution		
		total	Were inspected in 2015	Have the monitoring network
Akmola	103	6	5	6
3 areas in Akmola region	40	10	8	10
Aktobe	37	11	11	11
Almaty	103	10	10	10
Atyrau	11	5	5	10
Semipalatinsk area, East-Kazakhstan region	100	6	6	6
Ust-Kamenogorsk area, East-Kazakhstan region	17	13	13	13
Zhambyl	19	16	15	16
West-Kazakhstan	38	10	10	10
Karaganda	210	62	31	31
Kyzylorda	11	3	2	2
Kostanay	70	5	5	5
Mangistau	23	17	15	15
Pavlodar	255	22	22	22
North-Kazakhstan	47	1	1	4
Turkestan	29	17	3	17
Total in the Republic of Kazakhstan:	1113	214	162	188

Among the total number of monitored polluted sites, the majority of sites (250) are characterized by increased mineralization, the hardness of water; by sulfate and chloride content exceeding the MPC. About 87 sites are characterized by an increased content of nitrous compounds in groundwater, 52 sites - by an increased content of oil products, 63 sites - by an increased content of heavy metals, 45 sites - by an increased content of phenols, 92 sits - by an increased content of inorganic compounds and 30 sites - by an increased content of organic compounds.

By hazard class of detected pollutants, 114 monitored sites have moderately hazardous groundwater pollution, 51 sites have hazardous pollution, 34 sites have highly hazardous pollution and 15 sites have extremely hazardous class.

At 151 deposits and 44 intakes of groundwater used for domestic purposes, pollution of various classes is detected. In most cases, the pollution is associated with anthropization. Moderately hazardous pollution is detected at 64% of deposits, hazardous pollution - at 19% of deposits, extremely hazardous pollution - at 17% of deposits. The highest percentage of deposits with extremely hazardous pollution is in Karaganda region (44%), and in total, with hazardous pollution, it makes up half (50%) of all polluted groundwater deposits of the region. In East Kazakhstan region 72% of polluted deposits have hazardous and extremely hazardous pollution.

In Kazakhstan, there is the areal pollution of groundwater by oil products in the territories of almost all oil and gas production complexes. In addition, the pollution of groundwater by radionuclides is detected at oil production sites. The main sites of technogenic radioactive pollution of groundwater are at the Semipalatinsk nuclear test site and in the zone of its influence; in the places where peaceful nuclear explosions were conducted (including the so-called «Azgir trace» in the northern part of the Caspian Sea region); in the areas of radioactive waste burial and storage (especially in the territories of Kokshetausky, Kengir-Akbakaysky, and Chiganak-Aksuyeksky mining complexes); in the areas of currently developed uranium deposits, especially in the areas of the deposits which are developed by the method of underground leaching (in the Shu-Sarysusky mining complex where uranium deposits of Uvanas, Kanzhugan, Mynkuduk, and Moinkum are being developed).

Results. When conducting the research, the following main results were obtained:

1. The negative impact of anthropogenic factors on the state of groundwater in Kazakhstan is confined to industrial centers, urban agglomerations and environmental disaster zones in the Aral Sea region and at the Semipalatinsk nuclear test site.

2. Significant changes in the state of groundwater are associated with the anthropogenic impact on the regime of surface runoff due to its regulation in the river basins.

3. Important fact ors that change the state of groundwater in Kazakhstan include changes in the temperature regime of the territory and anthropogenic pollution of groundwater.

4. Changes in natural conditions under the influence of anthropogenic pressures cause a trend towards an overall reduction in available water resources.

5. A reduction in groundwater reserves of drinking water caused by progressive groundwater pollution of exploited aquifers is forecast in Kazakhstan.

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АНТРОПОҒЕНДІК ФАКТОРЛАРДЫҢ ҚАЗАҚСТАНДАҒЫ ЖЕР АСТЫ СУЛАРЫНЫҢ ЖАҒДАЙЫНА ТЕРІС ӘСЕРІ

Аннотация. Қоршаған ортаға антропогендік әсердің ұлғайуына байланысты оның күйінде сандық және сапалық өзгерістер, соның ішінде сулы қабаттар мен кешендердің гидрогеологиялық параметрлері болады. Антропогендік қысымдардың әсерінен пайда болатын және жер асты суларына,соның ішінде олардың қалыптасуына теріс әсер ететін физикалық-географиялық жағдайлардың негізгі өзгерістері: ауылшаруашылық жұмыстары, тау-кен жұмыстары, елді мекендер салу және т. б жағдайларда жергілікті ландшафтардың өзгеруі; гидроэнергетикалық объектілерді салу нәтижесінде гидрографиялық желінің өзгеруі; атмосфералық

ауа құрамының өзгеруі, жер асты суларының деңгей режимінің өзгеруі, климаттық жағдайлардың өзгеруі. Жер асты суларыныңқалыптасу жағдайларының өзгеруінің, олардыңресурстары мен сапасына теріс әсер ететін маңызды факторы,жер асты суларының прогрессивті антропогендік ластануы болып табылады.

Жер үсті агындарын антропогендік реттеудің әсері жер асты сулары ресурстарына айтарлықтай әсер етеді. Бір жағынан өзендерде резервуарларды құру су қоймасына іргелес жатқан аңғарлардың аллювиалды шөгінділерінде жер асты суларының ресурстарын көбейтеді, екінші жағынан, резервуарларды құру кезінде жер асты суларының жиналуы жер асты суларының деңгейінің жоғарылауына және су қоймаларының жағалауларында жер асты суларының тайыз пайда болуымен олардың бетінен буланудың жоғарылауына әкеледі, бұл жер асты сулары ресурстарының көлемін азайтады.

Жер асты суларының күйін өзгертудің маңызды факторы прогрессивті антропогендік ластану болып табылады, ол ресурстардың көлеміне тікелей әсер етпейді, бірақ кейбір жагдайларда судың сапалық сипаттамаларының санитарлық нормаларга сәйкес келмеуіне байланысты пайдалануга болатын жер асты суларының мөлшерін азайтады.

Қазақстан Республикасының аумағында ягни Ақтөбе, Ақмола, Алматы, Шыгыс Қазақстан және Оңтүстік Қазақстан облыстарында пайдалану шектелуіне, демек, жер асты суларының пайдалану қорларының азаюына әкелетін жер асты суларының ластануы байқалады.

Қазақстан аумагының геологиялық, геоморфологиялық, климаттық және топырақ-өсімдік жағдайларының алуан түрлілігі ландшафттардың алуан түрлілігін анықтайды. Күн жылуы солтүстіктен оңтүстікке қарай көтеріліп, жауын-шашын азая бастаган сайын табиги зоналарда тұрақты түрде өзгеріс болады: орманды дала, дала, шөлейт және шөл.

Қазақстанның ландшафттарына техногендік әсер айтарлықтай. Ландшафттардың өзгеруі жерлердің тым көп түсуінен, олардың батпақтануынан, табиги өсімдіктердің өсуінен және оның гидроморфты түрлермен алмастырылуынан көрінеді.

Табигатқа жан-жақты антропогендік әсер табиги аймақтардың пайда болуына айтарлықтай өзгерістер әкеледі. Ауылшаруашылық өндірісі - бұл Қазақстанның табиги-аумақтық кешендеріне әсер етудің негізгі түрі, ол жердің ландшафттық-экологиялық жағдайына айтарлықтай әсер етеді, ол елдің 85,3% құрайды. Ландшафттарга ауылшаруашылық әсерінің негізгі түрлері агрогендік, мелиоративті және жайылымдық болып табылады. Дала ландшафттары жогалады, жергілікті орман ландшафтары туындыларга ауыстырылады, батпақты жерлер құргап, шөлдер суарылады және т.б.

Жер асты суларының табиги режиміне антропогендік араласу экожүйелердің күйіне айтарлықтай әсер етеді. Жер асты суларының ресурстық әлеуетіне техногендік жүктемелердің күшеюі Қазақстандағы экологиялық және гидрогеологиялық жагдайлардың біртіндеп нашарлауына әкеледі. Бұл, ең алдымен, жер асты сулары ресурстарының сарқылуымен, депрессиялық шұңқырлардың және судың су астындағы аймақтарының пайда болуымен, жер асты суларының ластануымен, табиги ортаға (геологиялықты қоса алганда) және адам қоршаган ортасына айтарлықтай әсер етеді.

Соңгы жылдары ластанудың анықталган және ықтимал көздерінің саны іс жүзінде өзгеріссіз қалды, бұл республикадағы экономикалық құлдырауга, өнеркәсіптік және ауылшаруашылық өндірістің өсуінің төмендеуіне, сондай-ақ осы процестермен байланысты ластаушы заттар мен сарқынды сулардың төгілуінің төмендеуіне байланысты. Сонымен қатар, су айдындарының ластану деңгейінің бірқатар ингредиенттер бойынша жогарылауы байқалады, мүмкін мұндай ошақтарды залалсыздандыру бойынша жүйелі, мақсатты жұмыстардың болмауынан судың ағып кетуі бар су объектілеріне ластанудың таралган көздерін таратудың ұлғаюы.

Зерттеу әдісінің әдістемесі ретінде жер асты суларына антропогендік экологиялық өзгерістердің әсерін анықтау үшін Қазақстан аумағындагы гидрогеологиялық материалдарга кешенді талдау жасау қолданылды.

Түйін сөздер: Жер асты сулары, антропогендік өзгерістер, жер асты суларының ластануы.

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НЕГАТИВНОЕ ВОЗДЕЙСТВИЕ АНТРОПОГЕННЫХ ФАКТОРОВ НА СОСТОЯНИЕ ПОДЗЕМНЫХ ВОД КАЗАХСТАНА

Аннотация. Вследствие всевозрастающего антропогенного воздействия на окружающую среду в ее состоянии происходят количественные и качественные изменения, в том числе гидрогеологических параметров водоносных горизонтов и комплексов. Основными изменениями физико-географических условий, происходящими под воздействием антропогенных нагрузок и наиболее сильно влияющими на состояние

подземных вод, а также оказывающими негативное воздействие на условия их формирования, являются: изменение ландшафта местности при сельхозработах, разработке полезных ископаемых, строительстве населенных пунктов и др.; изменение гидрографической сети в результате строительства объектов гидроэнергетики; изменение состава атмосферного воздуха, уровенного режима подземных вод, климатических условий. Наиболее значимым фактором изменения условий формирования подземных вод, отрицательно влияющим на величину их ресурсов и качество, является прогрессирующее антропогенное загрязнение подземных вод.

Влияние антропогенного регулирования поверхностного стока в значительной степени влияет на ресурсы подземных вод. С одной стороны, создание водохранилищ на реках увеличивает ресурсы подземных вод в аллювиальных отложениях долин, примыкающих к водохранилищу, а с другой стороны – подпор подземных вод при создании водохранилищ вызывает повышение уровня подземных вод и увеличение испарения с их поверхности при неглубоком залегании подземных вод по берегам водохранилищ, что уменьшает объем ресурсов подземных вод.

Наиболее значительным фактором изменения состояния подземных вод является прогрессирующиее антропогенное загрязнение, не влияющее непосредственно на объем ресурсов, но, в ряде случаев, сокращающее объем доступных для использования ресурсов подземных вод из-за несоответствия качественных характеристик воды санитарным нормам.

На территории Республики Казахстан загрязнение подземных вод, вызывающее ограничение использования и, следовательно, уменьшение эксплуатационных запасов подземных вод, отмечается в Актюбинской, Акмолинской, Алматинской, Восточно-Казахстанской, Южно-Казахстанской областях.

Разнообразие геолого-геоморфологических, климатических и почвенно-растительных условий территории Казахстана обусловливает многообразие ландшафтов. По мере увеличения солнечного тепла с севера на юг и уменьшения осадков происходит последовательная смена природных зон: лесостепи, степи, полупустыни и пустыни.

Техногенное воздействие на ландшафты Казахстана довольно значительное. Изменение ландшафтов выражается в переувлажнении земель, их заболачивании, угнетении естественной растительности и замещении её гидроморфными видами.

Разностороннее антропогенное воздействие на природу приводит к существенным изменениям облика природных зон. Сельскохозяйственное производство является основным видом воздействия на природно-территориальные комплексы Казахстана, оно существенно влияет на ландшафтно-экологическое состояние земель, охватывая 85,3% земель страны. Основными видами сельскохозяйственного воздействия на ландшафты являются агрогенный, мелиоративный и пастбищный. Исчезают ландшафты степей, коренные лесные ландшафты заменяются производными, осушаются болота, орошаются пустыни и так далее.

Антропогенное вмешательство в естественный режим подземных вод оказывает существенное влияние на состояние экосистем. Интенсификация техногенной нагрузки на ресурсный потенциал подземных вод ведёт к прогрессирующему ухудшению эколого-гидрогеологических условий в Казахстане. Это связано, прежде всего, с истощением ресурсов подземных вод, образованием депрессионных воронок и зон подпора вод, загрязнением подземных вод, существенно влияющим на окружающую природную среду (в том числе на геологическую) и среду обитания человека.

В последние годы количество выявленных и потенциальных источников загрязнения остается практически неизменным, что обусловлено экономическим спадом в республике, снижением роста промышленного и сельскохозяйственного производства и связанным с этими процессами снижением сброса массы загрязняющих веществ и объемов сточных вод. Вместе с тем, наблюдается рост уровня загрязненности водных объектов по ряду ингредиентов, что, вероятно, обусловлено ростом поступления в водные объекты с поверхностным стоком рассеянных источников загрязнения в связи с отсутствием планомерных, целенаправленных работ по нейтрализации таких очагов.

В качестве методологии исследований использовался комплексный анализ гидрогеологических материалов по территории Казахстана с целью определения влияния антропогенных изменений окружающей среды на подземные воды.

Ключевые слова: подземные воды, антропогенные изменения, загрязнение подземных вод.

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REFERENCES

[1] Osipov S.V., Livinsky Yu.N., Yermenbai A.M. Influence of anthropogenic environmental changes on the groundwater formation in Kazakhstan // XIX International Multidisciplinary Scientific GeoConference SGEM 2019. Albena. Vol. 19. P. 337-342. ISBN978-619-7408-77-5. ISSN 1314-2704. doi: 10.5593/sgem2019/1.2 (in Eng.). Issue 2.2.

[2] Absametov M.K., Adenova D.K., Nusupova A.B. Assessment of the impact of antropogenic factors water resources of Kazakhstan //News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Almaty, 2019. Vol. 1. N 433 (2019). P. 248-254. ISSN 2518-170X (Online). ISSN 2224-5278(Print). Scopus, IF 0.067. https://doi.org/10.32014/2019.2518-170X.30

[3] Absametov M.K., Osipov S.V., Livinsky Yu.N., Murtazin Ye.Zh., Yermenbai A.M. Identification of prospective areas and assessment of groundwater resources of North and Central Kazakhstan for water supply of settlements. Almaty. P. 2017-277.

[4] National report on the environmental condition and on the use of natural resources for 2015. http://www.ecodoklad.kz

[5] Murtazin E., Miroshnichenko O., Trushel L. Structure of geoinformational and analytical system "groundwater resources and reserves of the republic of Kazakhstan" // News of the Academy of sciences of the Republic Kazakhstan. Series of geology and technical sciences. 2019. Vol. 3. N 435 (2019), P. 21-29. ISSN 2518-170X (Online), ISSN 2224-5278 (Print). (2019), Scopus, IF 0.067. https://doi.org/10.32014/2019.2518-170X.63

[6] Smolyar V.A., Burov B.V., Veselov V.V. and others. Water resources of Kazakhstan (surface and underground waters, current state). Directory. Almaty: Research Center "Gylym", 2002. P. 499-566.

[7] Mustafayev S.T., Smolyar V.A., Burov B.V. Hazardous geological processes in the territory of South-East Kazakhstan. Almaty: Research Center "Gylym". 2008. 258 p.

[8] Osipov S.V., Livinsky Yu.N., Yermenbay A.M., Gafurov Zafar. Change of formation conditions of groundwater of Kazakhstan under the influence of anthropogenic changes of the environment // News of National Academy of Sciences. Series of Geology and Technical Sciences, 2019. Vol. 3. N 435 (2019). P. 36-41. ISSN 2518-170X (Online), ISSN 2224-5278 (Print). (2019), Scopus, IF 0.067. https://doi.org/10.32014/2019.2518-170X.65

[9] Smolyar V.A. The impact of changes in the hydrogeodynamic regime of groundwater on the environment. Geology and subsurface protection. Almaty: KazGEO, 2017. N 1 (62). P. 54-62.

[10] Environmental dictionary, 2001. http://www.ecosystema.ru

[11] Onlasynov Zh., Akylbekova A., Sotnikov E., Rakhimov T., Kanafin K., Balla Dagmar. Implementation of the ersforyield analyzing of irrigated landsof South Kazakhstan // News of National Academy of Sciences. Series of Geology and Technical Sciences, Almaty, 2019. Vol. 4, N 436 (2019). P. 113-120. ISSN: 2224-5278 (Print). ISSN: 2518-170X (Online) Scopus, IF 0.067. https://doi.org/10.32014/2019.2518-170X.104