ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный исследовательский технический университет им. К. И. Сатпаева

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Kazakh national research technical university named after K. I. Satpayev

ГЕОЛОГИЯ ЖӘНЕ ТЕХНИКАЛЫҚ ҒЫЛЫМДАР СЕРИЯСЫ

♦

СЕРИЯ ГЕОЛОГИИ И ТЕХНИЧЕСКИХ НАУК

♦

SERIES OF GEOLOGY AND TECHNICAL SCIENCES

4 (430)

ШІЛДЕ – ТАМЫЗ 2018 ж.
ИЮЛЬ – АВГУСТ 2018 г.
JULY – AUGUST 2018

ЖУРНАЛ 1940 ЖЫЛДАН ШЫҒА БАСТАҒАН
ЖУРНАЛ ИЗДАЕТСЯ С 1940 г.
THE JOURNAL WAS FOUNDED IN 1940.

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR

АЛМАТЫ, ҚР ҰҒА АЛМАТЫ, НАН РК ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология мен техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген **№10892-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18, http://nauka-nanrk.kz /geology-technical.kz

Редакцияның мекенжайы: Қазақстан, 050010, Алматы қ., Қабанбай батыра көш., 69а.
Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№10892-Ж,** выданное 30.04.2010 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18, http://nauka-nanrk.kz /geology-technical.kz

Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.
Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz/geology-technical.kz

Editorial address: Institute of Geological Sciences named after K.I. Satpayev
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 3, Number 430 (2018), 132 – 144

UDC 556.3.06(574)

K. M. Kanafin[1], I. K. Rakhmetov[2]

[1]The Kazakh National Research Technical University after K. I. Satpaev, Almaty, Kazakhstan,
[2]Institute of Hydrogeology and Geoecology named after U. M. Akhmedsafin, Almaty, Kazakhstan.
E-mail: km_kanat_2008@mail.ru, issa-92@mail.ru

ESTIMATE OF FORECAST RESOURCES OF UNDERGROUND WATER IN NARYN SANDY AREA

Abstract. To solve the problems related to water supply to rural population centers and cattle farms, irrigation of pastures within the territory, regional hydrogeology surveys were conducted in the territory of Naryn sand massif in Northern Pre-Caspian.

Hydrogeological justification of the underground water use prospectivity is in estimating its forecast resources. With the purpose of studying the current state of surface and underground water within the territory under study, regional studies were conducted. Underground water of sandy Aeolian deposits within borders of Naryn sands is caught mainly by wells excavated and equipped manually for non-centralized drinking water supply of cattle farms and small population centers, and also for cattle watering points. Previously explored underground water fields in Aeolian deposits are not operated.

Regional hydrogeological zoning with the purpose of estimating the resources of fresh and low-mineralized water is based on general geological and hydrogeological representations, results of regional route studies. It was carried out with account to the following characteristics of water-bearing formations: perspective water-bearing formation spread contour; underground water occurrence depth; water-bearing formation thickness; underground water mineralization.

To estimate forecast resources of Naryn sands underground water, identified were basic sources of their formation: natural (volumetric) reserves, natural (renewable) resources.

The estimate of forecast underground water resources was carried out using traditional and hydrodynamic methods. Methodology developed by scientists of the Institute of Hydrogeology and Geoecology named after U. M. Ahmedsafin was used as conventional estimate method.

In the process of scientific research, regional map of modules of Naryn sands underground water resources was built. Data was processed and maps were built with the use of up-to-date geoinformational software systems Geomatica 2016 and ArcGIS 10.5.

Key words: interstitial underground water, Naryn sands, Nothern Pre-Caspian, hydrogeological parameters, natural reserves, natural resources, hydrogeological zoning, hydrodynamic method, forecast useful resources.

Introduction. The most acute problem in Kazakhstan is the supplying population with quality drinking water. The whole number of regions, including Western Kazakhstan experiences deficit in fresh water.

Hydrogeological conditions and the status of Western Kazakhstan level of water supply is characterized by highly intense water resources balance. This is first of all characteristic for Pre-Caspian oblasts (Atyrau, Mangistau and south-west of half of Western Kazakhstan oblast). Due to the absence of surface water, almost the only source of all types of water supply is the underground water. Hydrogeologically, underexplored until now territory of Naryn sands (interfluve of Volga and Zhaiyk (Ural)) [1, 2] is of significant interest.

Prospectivity of a vast sandy massif is estimated not only by multiple data about presence of fresh water lenses of considerable size, large dishes and estuaries, and also the development of large confluent macrotuberous ridges and massifs of barchans type. Aeolian sand are underplayed here with waterpermeable formations of Khvalynskiy age. These sands having relatively well filtering surfaces and interstitial reservoirs, created are favorable conditions for the filtration of precipitation and absorption of land runoff, drainage and driving of fossil saline water, which results in the formation of fresh lenses [3, 4].

One of the most important problems is the forecast of the prospects of using underground water resources for water supply, irrigation and watering. Such forecast must be hydrogeologically substantiated. Hydrogeological justification of the underground water use is in the estimate of their forecast useful resources.

Borders of the territory under study with the purpose of underground water resources estimate (figure 1) are identified by hydrogeological map having scale of 1:500 000 and are adjusted with the use of remote-sensed data (RSD) [5-8]. RSD processing was performed with the use of geoinformation software Geomatica 2016 (PCI Geomatics). Maps building and their further visualization was implemented in the software system ArcGIS 10.5 (ESRI).

When estimating forecast resources of Naryn sands underground water, identified were the key sources of its formation: natural (volumetric) reserves, natural (renewable) resources [9].

Conditions for underground water resources formation. Ground (nonartesian) water of the Northern Pre-Caspian are connected with different by lithologic-and-facies composition and genesis of Quarternary age rock occurring not deep from the day surface and exposed to direct impact of climatic and hydrological drug factors [1, 2, 4-10].

The major source of ground water resources replenishment in the territory under study are precipitations and in wellhead areas of rivers and their affluent - surface water (flood run-off). Favorable conditions of ground water resources replenishment and formation at account of precipitations are observed within the areas of Aeolian formations development. In the estuarine part of Mal and Bol. Uzen river

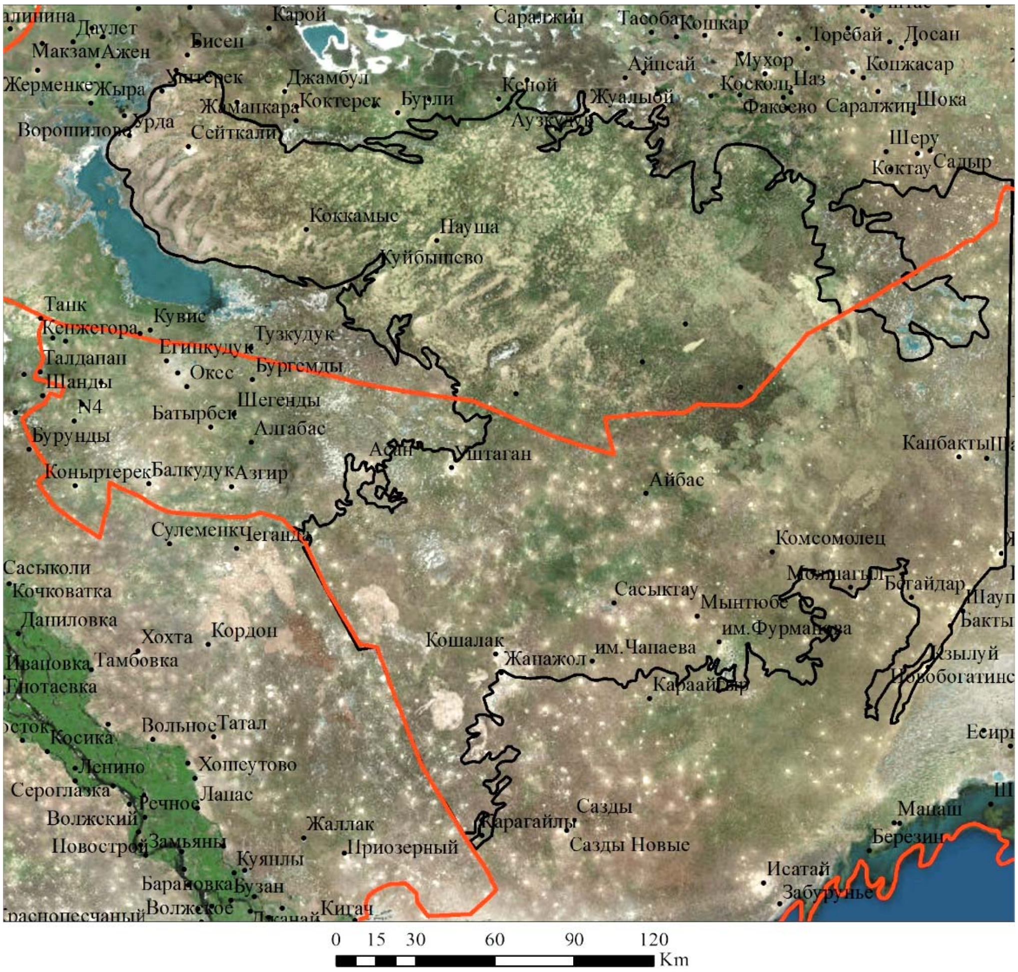


Figure 1 – Sketch map of Naryn sands location

valleys, favorable conditions are also noted for the underground water formation not only at account of precipitations, but filtration of river floodwater. Such conditions of groundwater feed within the areas of sand spread facilitate the formation of major reserves of fresh water.

In general, studies conducted previously within the territory of Naryn sands revealed fresh ground water [4]. Underground water here is desalted throughout the full thickness of water-bearing sand. This is explained by the fact that along with favorable fed conditions, water-bearing formations have a powerful discharge site - Khaki playa, spreading from north-west to south-east in the form of slightly curved horseshoe and embedded into the surrounding valley by 10-25 m.

The underflow is discharged into the basin of the Caspian Sea, and also by evaporation in case of its shallow occurrence. Local points of discharge are shut-ins and topographic lows.

Field studies were conducted with the purpose of studying the current state of surface and underground water of the territory under study (figure 2). Described were 34 observation points, were 26 water samples were taken for chemical analysis. The total length of routes – 1,160 km.

Figure 2 – Field route surveys within the territory of Naryn sands

Based on the results of the field routing surveys, the following can be noted:

1. Fresh underground water with mineralization of up to 1.0 g/dm^3 is 58 % of the sampled water. Their composition from bicarbonate and bicarbonate-sulphate to three-anionic with predomination of sodium cations, hardness within 2-10 mg-eq/dm^3, pH 6,9-8,2 (water from neutral to weakly alkaline).

2. Underground water with mineralization of more than 1,0 g/dm^3 has chloride-sulphate and sulphate-chloride sodium, sodium-magnesium chemical composition, with hardness of more than 10,0 mg-eq/dm^3 and faintly alkaline reaction.

3. Underground water of sand Aeolian formations within Naryn sands is mainly captured by wells made and equipped manually. Fresh underground water is used for non-centralized drinking water supply of cattle farms and small population centers, and also for cattle watering points. More mineralized underground water is taken for cattle drinking places on specifically equipped sites (manually or with pumps, drinking reservoirs etc.).

4. Explored underground water fields of Aeolian deposits are not operated. Previously drilled holes were plugged.

5. Results of route surveys confirm the presence of fresh underground water in Quarternary Aeolian deposits both in the form of lenses, as well as water-bearing formations perspective for development with the purpose of utility and drinking water supply.

Hydrogeological zoning of the territory under study was carried out for the further estimation of underground water forecast resources and separating perspective areas of underground water sources and is based on geological-hydrogeological representations, results of regional studies.

The zoning was carried out with the account to the following characteristics of water-bearing formations: contour of perspective water-bearing formation spread; underground water depth of occurrence; water-bearing formation thickness; underground water mineralization. The total area of the territory to be estimated within Northern Pre-Caspian (Naryn sands) was – 30,5 thousand km^2. Zoning results are presented in table 1 and figure 3.

Table 1 – Hydrogeological zoning of Naryn sands

A. By underground water mineralization				
Research area	Areas of underground water spread (km^2) with mineralization, g/dm^3			
	to 1,0	1,0-3,0	more than 3,0	in all
Naryn sands	12115	16295	2089	30499
Б. По мощности водоносного горизонта				
Research area	Areas of water-bearing formations spread (km^2) with thickness, m			
	less than 5,0	5,0-10,0	more than 10,0	in all
Naryn sands	3876	14539	12084	30499

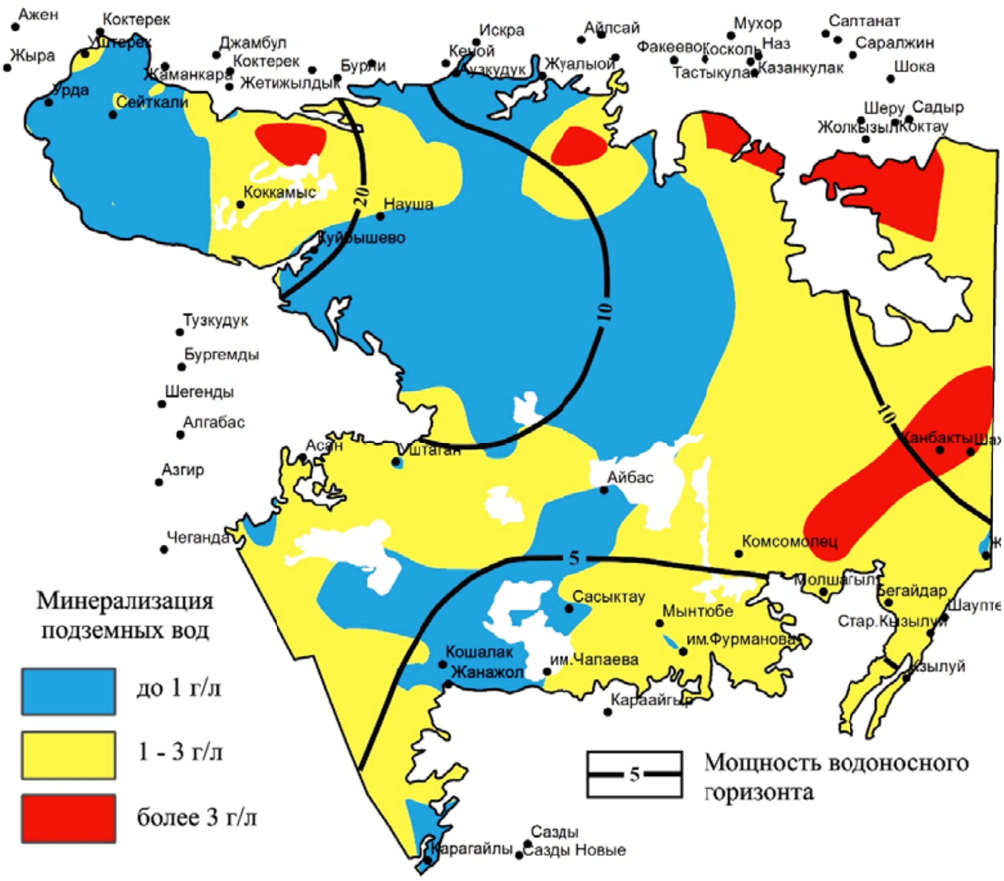


Figure 3 – Schematic map of Naryn sands territory zoning

The area of fresh underground water spread is estimated as 12,11 thousand km^2 or 39,7 %, and subsaline underground water with mineralization of 1-3 g/dm^3 – 16,29 thousand km^2 or 53,4 %. By thickness of water-bearing formation, prevailing by the area is the value of less than 5,0-10,0 m (14,53 thousand km^2 or 47,6 %). The territory with water-bearing formation thickness of more than 10 m is estimated as 12,0 thousand km^2 or 39,6 %.

Natural reserves (V_e) of interstitial nonartesian underground water of Naryn sands were calculated by formula:

$$V_e = \mu \cdot m \cdot F, \quad (1)$$

where V_e – natural (volumetric) reserves of underground water, m^3; μ – gravitation filtration-loss factor, as decimal fraction; m – average value of water-bearing formation thickness, m; F – area of water-bearing formation spread within the territory under study, m^2.

Values (m) and (F) are taken by schematic zoning map (figure 3). Value (μ) was determined by data of exploration within Naryn sands area and varies within 0,11-0,16, mean value being 0,13.

Natural reserves of interstitial underground water in Naryn sands territory is estimated as 42582,7 mln. m^3, natural reserves module varies within 0,39-2,6 mln. m^3/km^2 depending on water-bearing formation thickness, making on average in the territory under study – 1,39 mln. m^3/km^2. Estimates are presented in table 2.

Table 2 – Natural reserves of Naryn sands interstitial underground water

Area of spread, km^2	Average thickness, m	Water loss factor, decimal fraction	Natural reserves, mln. m^3	Natural reserves module, mln. m^3/$км^2$
3876	3,0	0,13	1511,64	0,39
14539	8,0	0,13	15120,56	1,04
8398	15,0	0,13	16376,1	1,95
3686	20,0	0,13	9583,6	2,6
30499	**10,74**	**0,13**	**42582,7**	**1,39**

Natural resources (Q_e) interstitial nonartesian Naryn sands underground water are estimated as annual feeding at account of precipitation infiltration under natural conditions. For the conditions of sand massifs, the value of effective precipitation infiltration was identified by meteorological method, which is based on long-term observations of precipitation in the territory used in calculation of infiltration.

The following equation serves a structural basis:

$$Q_e = \frac{H_{эфф} \cdot K_{инф} \cdot F}{31,536 \cdot 10^6}, \quad (2)$$

where Q_e – natural resources of underground water formed at account of precipitation infiltration, m^3/s; $H_{эфф}$ – average annual total of effective precipitation, m; $K_{инф}$ – infiltration factor used by analogy; F – area of estimate, km^2; Value $K_{инф}$, was identified by analogy for which engaged were the results of studies of Aeolian sand massifs underground water formation processes in arid regions.

So, a complex of observation works was performed by specialists of the State Hydrology Institute (SHI) on Khvalynskiy valley [11-14]. At similar site $K_{инф}$ decreases with the depth and at the level of 10-11 meters reaches the value of 0.10-0.12. For the conditions of Moiynkum sand massifs, the value of feed for unfixed sand by data of observations of lysimeters installed at the depth of 4.5 m, was 0.1-0.38 of the total of effective precipitation. Besides, used were the results of review of published materials related to the issue of underground water feeding under conditions of arid climate. In particular, these included the works of Bindeman N.N., Wolfzung N.B., Ganiev K.G., Ostrovskiy N.S., and also the results of MSU laboratory studies. As the result of critical review of the listed materials, and also based on the results of previous estimates, with account to the fact that the depth of underground water occurrence at water points was less than 3,0 m, and the value of effective precipitation infiltration factor for Naryn sands was taken as equal to 0,2.

Design totals of precipitation were identified by data of long-term observations on the network of meteorological stations [15]. Average totals of precipitation in the territory of Naryn sands are presented in figure 4. Effective total of precipitation ($H_{эфф}$) of the cold season for the territory under study vary within 35-42%, making on average 39% of the annual level.

Natural resources of interstitial underground water within Naryn sands territory are estimated as 16,59 m^3/s, and the module of natural resources varies within 0,43-0,65 $l/s \cdot km^2$ depending on the level of effective precipitation making on average in the territory under study – 0,54 $l/s \cdot km^2$. Results of calculations are presented in table 3.

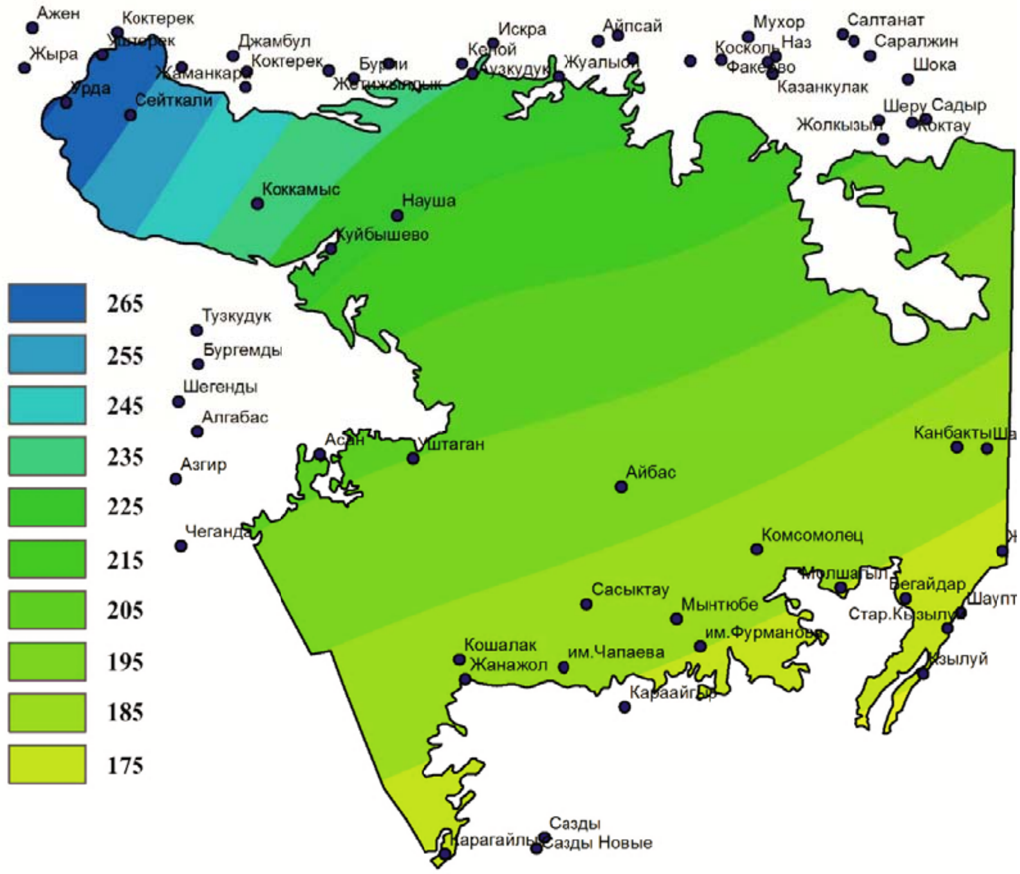


Figure 4 – Average amount of precipitation (mm/year)

Table 3 – Natural resources of Naryn sands interstitial underground water

Area of spread, km^2	Average annual amount of precipitation, mm		Infiltration factor, decimal factor	Natural resources, m^3/s	Module of natural resources, l/s·km^2
	annual total	effective			
1851	175,0	68,25	0,2	0,80	0,43
6765	185,0	72,15	0,2	3,09	0,46
7811	195,0	76,05	0,2	3,76	0,48
4888	205,0	79,95	0,2	2,47	0,50
3475	215,0	83,85	0,2	1,84	0,53
2270	225,0	87,75	0,2	1,26	0,56
1100	235,0	91,65	0,2	0,64	0,58
791	245,0	95,55	0,2	0,48	0,60
795	255,0	99,45	0,2	0,50	0,63
750	265,0	103,35	0,2	0,49	0,65
30496	**220,0**	**85,8**	**0,2**	**16,59**	**0,54**

The estimate of forecast resources ($Q_э$) of underground water was performed with the use of balance and hydrodynamic methods of estimate on the basis of zoning map by conditions of underground water formation with account to conditions-forming factors and modules of infiltration feed.

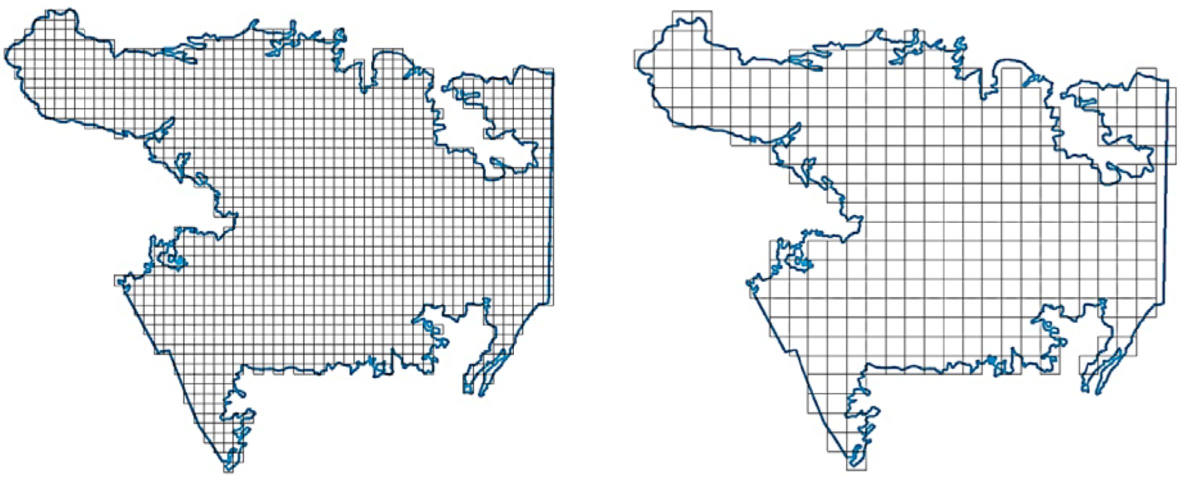
When estimating regional forecast resources used was the methodology developed by scientists of the Institute of Hydrogeology and Geoecology named after U. M. Ahmedsafin, who for more than 50 years had been dealing with the studies of Kazakhstan underground water formation and distribution regularities. In calculations, used was the formula proposed by U. M. Ahmedsafin [16-18]:

$$Q_э = \frac{V_e}{2 \cdot 100 \cdot 31,536 \cdot 10^6} + 0,7Q_e, \qquad (3)$$

where $Q_э$ – forecast regional useful resources of underground water, m^3/s; V_e – natural reserves of underground water, m^3; Q_e – natural resources of underground water, m^3/s.

Design value of forecast regional useful resources of Naryn sands underground water is 18,36 m^3/s. These values represent potential using possibilities of the territory under study.

Hydrodynamic methods of estimating forecast resources of underground water included a method of calculations applicable to the conventional even grid of wells [19, 20] throughout the Naryn sands area to be estimated. Grid size with account to geological-hydrogeological conditions and variability of the thickness of water-bearing sediments and underground water mineralization was taken as 5.0 and 10.0 km. Each single water intake structure is conditionally schematized as working in the closed circular block with impermeable boundaries at account of natural reserves included into such block, and also natural resources corresponding to its area (figure 4).



a b

Figure 4 – Examples of model grids with block size of 5x5 km (a), 10x10 km (b)

Block radius ($R_б$), equal to circle radius of equal area with square block of the grid is determined from expression:

$$R_б = \frac{\Delta x}{\sqrt{\pi}} = 0,565\Delta x, \qquad (4)$$

where Δx – grid size, m.

A single water intake structure flow for free-flow interstitial water located in the center of the block, us found by formula:

$$Q_э = \frac{\left[S(1-\frac{S}{2m}) + Q_e \frac{T}{\pi \mu R_б^2} \right] \pi R_б^2}{\frac{T}{\mu} + \frac{R_б^2}{2km} \cdot \ln \frac{R_б}{r}} \qquad (5)$$

where $Q_э$ – capacity of water intake structure, m^3/daily; Q_e – additional feeding at account of natural resources, m^3/daily; S – allowable level lowering, m; m –water-bearing formation thickness, m; k – filtration factor, m/daily; T – design life cycle, days; μ – gravitation filtration-loss factor, decimal fraction; $R_б$ – block radius, m; r – radius of water intake structure well, m.

In calculations, the following input data was used:

a) additional feed coming to a block area at account of precipitation infiltration, identified by module of natural resources from expression:

$$Q_e = 86400M_e, \qquad (6)$$

where M_e – module of natural resources, l/s·km^2.

b) the given radius of a single water intake structure is taken as equal to block radius ($R_б$) when calculating by even grid and is equal with the grid size of 5 km and 10 km, 2,825 m and 5,650 m accordingly. Radius of water supply well (r), by operating experience – 0,1 m.

c) useful reserves were calculated for 50-year period of operation, or 18,250 days with two options.

d) value of allowable decrease of level was identified provided natural reserves drawdown by half of thickness of water-bearing formation (S=0.5t).

e) design hydrogeologic parameters of water-bearing formations are determined by results of development works, performed previously on underground water exploration sites. Value (μ) is taken as 0,13. Value (k) in the area of Naryn sands varies within 5,8-20,7 m/daily and for forecast calculations is - 6 m/daily.

f) total forecast useful resources of underground water were estimated for sand water-bearing formations with mineralization of up to 1 and 1-3 g/dm^3 with account to the use of underground water for utility and drinking water supply and cattle drinking place, by formula:

$$Q_Э = \sum_{i=1}^{n} Q_i \;, \qquad (7)$$

where Q_i – intake facilities flow rate in i-block (i = 1, 2, 3, ..., n); n – number of blocks in the area to be estimated.

Results of calculations of forecast useful resources by analytical method are presented in tables 4-7. With account to conventional even grid of wells throughout the Naryn sands area under study with grid size of 5 km, forecast useful resources of underground water were taken by the 2-nd option of calculation. Value of forecast useful resources of underground water for the Naryn sands territory to be estimated is 108,07 m^3/s, including: fresh water (up to 1 g/dm^3) – 54,27 m^3/s, and light subsaline (1-3 g/dm^3) – 53,8 m^3/s.

Table 4 – Forecast resources of fresh underground water (Δx – 10 km)

Underground water mineralization, g/dm^3	Area of spread, km^2	Number of blocks, pcs	Thickness, m	Module of natural resources, l/s·km^2	Single intake facility capacity, m^3/day	Forecast useful resources		Module of forecast resources, l/s*km^2
						thousand m^3/daily	m^3/s	
Fresh (to 1)	747	7	20	0,65	5412,52	37,89	0,44	0,59
	757	7	20	0,63	5260,48	36,82	0,43	0,56
	570	5	20	0,6	5032,42	25,16	0,29	0,51
	183	1	15	0,58	3652,27	3,65	0,04	0,23
	130	1	20	0,56	4728,33	4,73	0,05	0,42
	417	4	15	0,56	3535,68	14,14	0,16	0,39
	468	4	8	0,56	1877,36	7,51	0,09	0,19
	1824	18	15	0,53	3360,78	60,49	0,70	0,38
	505	5	8	0,53	1781,05	8,91	0,10	0,20
	2006	20	15	0,5	3185,89	63,72	0,74	0,37
	1298	12	8	0,5	1684,74	20,22	0,23	0,18
	154	1	15	0,48	3069,29	3,07	0,04	0,23
	1869	18	8	0,48	1620,54	29,17	0,34	0,18
	122	1	3	0,48	603,05	0,60	0,01	0,06
	101	1	8	0,46	1556,33	1,56	0,02	0,18
	897	8	3	0,46	578,40	4,63	0,05	0,06
	136	1	3	0,43	541,43	0,54	0,01	0,05
Total	**12184**	**114**				**322,81**	**3,74**	**0,31**

Table 5 – Forecast resources of subsaline underground water (Δx – 10 km)

Underground water mineralization, g/dm^3	Area of spread, km^2	Number of blocks, pcs	Thick-ness, m	Module of natural resources, l/s*km^2	Single intake facility capacity, m^3/day	Forecast useful resources		Module of forecast resources, l/s*km^2
						thousand m^3 daily	m^3/s	
Subsaline (1 – 3)	311	3	20	0,6	5032,42	15,10	0,17	0,56
	570	5	20	0,58	4880,37	24,40	0,28	0,50
	100	1	15	0,58	3652,27	3,65	0,04	0,42
	403	4	20	0,56	4728,33	18,91	0,22	0,54
	554	5	15	0,56	3535,68	17,68	0,20	0,37
	205	2	8	0,56	1877,36	3,75	0,04	0,21
	182	1	15	0,53	3360,78	3,36	0,04	0,21
	712	7	8	0,53	1781,05	12,47	0,14	0,20
	430	4	15	0,5	3185,89	12,74	0,15	0,34
	637	6	8	0,5	1684,74	10,11	0,12	0,18
	1074	10	15	0,48	3069,29	30,69	0,36	0,33
	4558	45	8	0,48	1620,54	72,92	0,84	0,19
	464	4	15	0,46	2952,70	11,81	0,14	0,29
	2451	24	8	0,46	1556,33	37,35	0,43	0,18
	1821	18	3	0,46	578,40	10,41	0,12	0,07
	794	7	8	0,43	1460,02	10,22	0,12	0,15
	872	8	3	0,43	541,43	4,33	0,05	0,06
Total	**16138**	**154**				**299,92**	**3,47**	**0,22**

Table 6 – Forecast resources of fresh underground water (Δx – 5 km)

Underground water mineralization, g/dm^3	Area of spread, km^2	Number of blocks, pcs	Thickness, m	Module of natural resources, l/s*km^2	Single intake facility capacity, m^3/day	Forecast useful resources		Module of forecast resources, l/s*km^2
						thousand m^3/daily	m^3/s	
Fresh (to 1)	747	30	20	0,65	16785,38	501,55	5,80	7,77
	757	30	20	0,63	16280,93	492,99	5,71	7,54
	504	20	20	0,6	15524,26	312,97	3,62	7,19
	66	3	20	0,58	15019,81	39,65	0,46	6,95
	183	7	15	0,58	12072,66	88,37	1,02	5,59
	130	5	20	0,56	14515,37	75,48	0,87	6,72
	417	17	15	0,56	11664,54	194,56	2,25	5,40
	468	19	8	0,56	6925,36	129,64	1,50	3,21
	1824	73	15	0,53	11052,36	806,38	9,33	5,12
	505	20	8	0,53	6558,42	132,48	1,53	3,04
	2006	80	15	0,5	10440,18	837,72	9,70	4,83
	1298	52	8	0,5	6191,48	321,46	3,72	2,87
	154	6	15	0,48	10032,06	61,80	0,72	4,64
	1869	75	8	0,48	5946,86	444,59	5,15	2,75
	122	5	3	0,48	2427,05	11,84	0,14	1,12
	101	4	8	0,46	5702,23	23,04	0,27	2,64
	897	36	3	0,46	5654,85	202,90	2,35	2,62
	136	5	3	0,43	2175,45	11,83	0,14	1,01
Total	**12184**	**487**				**4689,25**	**54,27**	**4,45**

Table 7 – Forecast resources of subsaline underground water (Δx – 5 km)

Underground water mineralization, g/dm^3	Area of spread, km^2	Number of blocks, pcs	Thickness, m	Module of natural resources, l/s*km^2	Single intake facility capacity, m^3/day	Forecast useful resources		Module of forecast resources, l/s*km^2
						thousand m^3/daily	m^3/s	
Subsaline (1 – 3)	37	1	20	0,63	16280,93	24,10	0,28	7,54
	274	11	20	0,6	15524,26	170,15	1,97	7,19
	570	23	20	0,58	15019,81	342,45	3,96	6,95
	100	4	15	0,58	12072,66	48,29	0,56	5,59
	403	16	20	0,56	14515,37	233,99	2,71	6,72
	554	22	15	0,56	11664,54	258,49	2,99	5,40
	205	8	8	0,56	6925,36	56,79	0,66	3,21
	182	7	15	0,53	11052,36	80,46	0,93	5,12
	712	28	8	0,53	6558,42	186,78	2,16	3,04
	430	17	15	0,5	10440,18	179,57	2,08	4,83
	637	25	8	0,5	6191,48	157,76	1,83	2,87
	1074	43	15	0,48	10032,06	430,98	4,99	4,64
	4558	182	8	0,48	5946,86	1084,23	12,55	2,75
	431	17	15	0,46	9623,93	165,92	1,92	4,46
	2451	98	8	0,46	5702,23	559,05	6,47	2,64
	1821	73	3	0,46	5654,85	411,90	4,77	2,62
	33	1	15	0,43	9011,75	11,90	0,14	4,17
	794	32	8	0,43	5335,29	169,45	1,96	2,47
	872	35	3	0,43	2175,45	75,88	0,88	1,01
Total	**16138**	**646**				**4648,12**	**53,80**	**3,33**

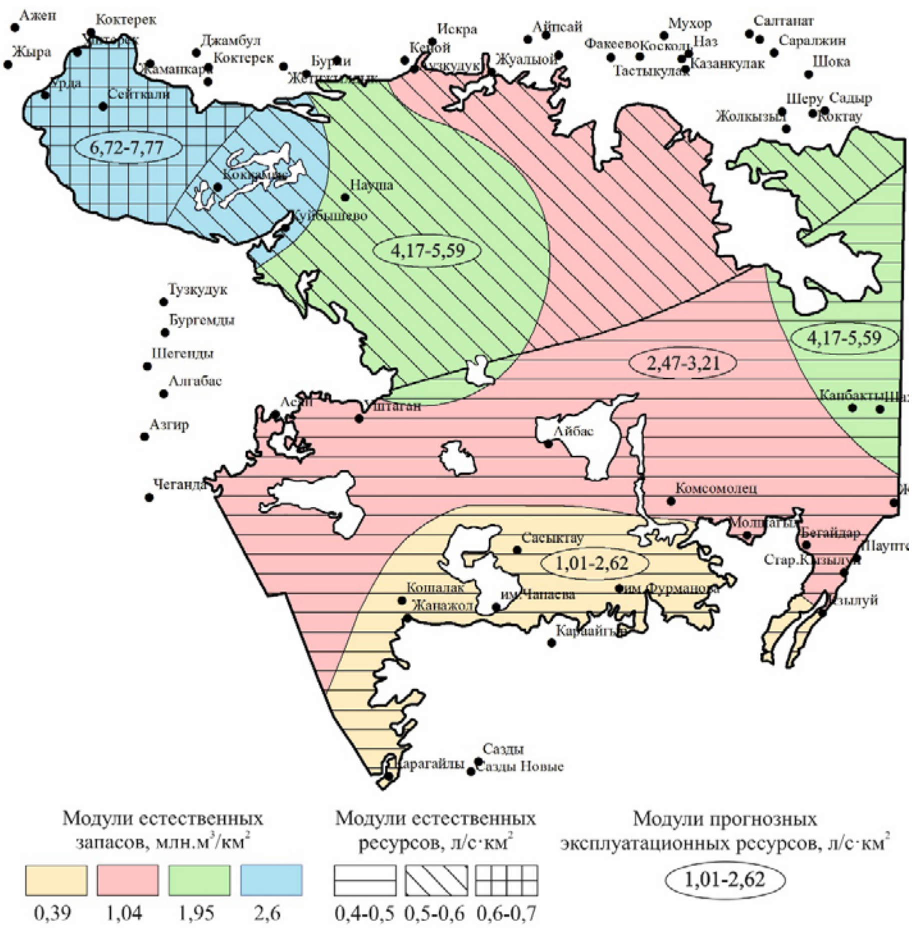


Figure 5 – Map of Naryn sands underground water resources

In the process of scientific studies, based on data of analysis of previously performed works, materials of RSD and field route surveys, regional map of Naryn sands underground water resources was made (figure 5). The map shows modules of natural resources (mln. m^3/km^2), natural and forecast useful resources ($l/s{\cdot}km^2$) of underground water.

Conclusion:

1. Based on data of hydrogeological zoning, the area of spread of fresh underground water was estimated as 12,11 thousand km^2 or 39,7 %, By thickness of water-bearing formation, prevailing by the area is the value of less than 5,0-10,0 m (14,53 thousand km^2 or 47,6 %). The territory with water-bearing formation thickness of more than 10 m is estimated as 12,0 thousand km^2 or 39,6 %.

2. Field studies allowed estimation of the quality of used water resources. Fresh underground water with mineralization of up to 1,0 g/dm^3 make 58% of the taken water. Their composition from bicarbonate and bicarbonate-sulphate with predomination of sodium cations, hardness within 2-10 mg-eq/dm^3, pH 6.9-8.2 (water from neutral to weakly alkaline). Underground water with mineralization of more than 1,0 g/dm^3 has chloride-sulphate and sulphate-chloride sodium, sodium-magnesium chemical composition, with hardness of more than 10,0 mg-eq/dm^3 and faintly alkaline reaction. Results of route surveys confirm the presence of fresh underground water in Quarternary eolian deposits both in the form of lenses, as well as water-bearing formations perspective for development with the purpose of utility and drinking water supply.

3. Calculations of natural reserves of free-flow Naryn sands underground water are estimated as – 42582,7 mln. m^3, natural reserves module was on average – 1,39 mln. m^3/km^2. Natural resources of Naryn sands underground water are estimated as 16,59 m^3/s, module of natural resources – 0,54 $l/s{\cdot}km^2$ on average.

4. The value of forecast useful resources of underground water for the Naryn sands territory under study is 108,07 m^3/s, including: fresh water (up to 1 g/dm^3) – 54,27 m^3/s and light subsaline (1-3 g/dm^3) – 53,8 m^3/s. Major part of resources of fresh and light subsaline underground water is concentrated in the northern part of Naryn sands massif.

REFERENCES

[1] Veselov V.V., Sydykov Zh.S. Hydrogeology of Kazakhstan, **2004.** 484. (in Eng.).

[2] Hydrogeology of the USSR. Vol. XXXV, Western Kazakhstan. M.: Nedra, **1971.** 522. (in Eng.).

[3] Satpayev A.G., Kugeshev A.K. On the study of hydrogeological conditions in the Caspian region using the latest aerospace surveys // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of geology and technical sciences. **2008**. Vol. 2. P. 62-65. UDC 556.3: 550.54(574.1). (in Eng.).

[4] Veselov V.V., Makhmutov T.T. and etc. Deposits of underground waters of Kazakhstan, Volume I. Western and Southern Kazakhstan: directory. Almaty, **1999**. 290. (in Eng.).

[5] Kanafin K.M., Shagarova L.V. Methods of remote sensing in regional hydrogeological research on the example of Western Kazakhstan, Science today: postulates of the past and modern theories as a mechanism for effective development in a crisis, March 25-26, **2016**, 14-20. (in Eng.).

[6] Kanafin K.M., Ibraimov V.M. Sattelite images interpretation using GIS in hydrogeological surveys, Bulletin of the National Academy of Sciences of the Republic of Kazakhstan. ISSN 1991-3494. Vol. 6, N 364 (**2016**), 27-33. (in Eng.).

[7] Tokareva O.S. Processing and interpretation of Earth remote sensing data: textbook. Tomsk: Publishing house of Tomsk Polytechnic University, **2010**. 148. (in Eng.).

[8] Remote sensing applications то groundwater // IHP-VI. Series on Groundwater N 16. UNESCO, 2007. (in Eng.).

[9] Groundwater Studies. An international guide for hydrogeological investigations // IHP-VI. Series on groundwater N 3.UNESCO **2004**. (in Eng.).

[10] Sydykov Zh.S. Underground waters of the Caspian oil and gas region (formation, resources and use) // National Center of Science and Technology Evaluation JSC. Almaty, **2001**. 368 p. (in Eng.).

[11] Dzhakelov A.K. Formation of underground waters of the Chu-Sarysu Artesian Basin, Almaty, **1993**. 294. (in Eng.)

[12] Methods for studying and calculating the water balance. L.: Gidrometeoizdat, **1981.** (in Eng.).

[13] Ostrovsky V.N. Underground waters of deserts and ecosystems. M.: Nedra, **1991.** (in Eng.).

[14] Chubarov V.N. Groundwater supply of sandy desert through aeration zone. M.: Nedra, **1972**. (in Eng.).

[15] A Guide to Kazakhstan's Climate, The long-term data of 1971-2000, RSE Kazhydromet. Almaty, **2004.** (in Eng.)

[16] Ahmedsafin U.M. Hydrogeological zoning and regional assessment of groundwater resources in Kazakhstan. Alma-Ata: Science, **1964**. 309 p. (in Eng.).

[17] Ahmedsafin U.M. Regional resources of underground waters of Kazakhstan. Alma-Ata, **1983.** (in Eng.)

[18] Ahmedsafin U.M. Forecast map of Kazakhstan's regional water availability with groundwater resources of 1: 2 500 000 scale. Alma-Ata, **1983.** (in Eng.)

[19] Bindeman N.N., Yazvin L.S. Estimation of the operational reserves of groundwater. M.: Nedra, **1970**. 216. (in Eng.)

[20] Borevsky B.V., Drobnokhod N.I., Yazvin L.S. Assessment of groundwater resources. 2nd ed. **1989**, 407. ISBN 5-11-001204-0. (in Eng.).

Қ. М. Канафин[1], И .Қ. Рахметов[2]

[1]Қ. И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті, Алматы, Қазақстан,
[2]У. М. Ахмедсафин атындағы гидрогеология және геоэкология институты,
Алматы, Қазақстан

НАРЫН ҚҰМДАРЫНЫҢ ЖЕРАСТЫ СУЛАРЫНЫҢ БОЛЖАМДЫ РЕСУРСТАРЫН БАҒАЛАУ

Аннотация. Ауылдық елді мекендерді, мал шаруашылығын және жайылымдық аудандарды суару сумен қамтамасыз етуге байланысты мәселелерді шешу үшін Солтүстік Каспий маңындағы Нарын құмды массив аумағында аймақтық гидрогеологиялық зерттеулері жүргізілген.

Жерасты суларын пайдалану тиімділігін гидрогеологиялық негіздемесі олардын болжамды ресурстарын бағалауы болып келеды. Жерүсті және жерасты суларының қазіргі заманғы жағдайын зеттеу мақсатында осы ауданда аймақтық экспедициялық зерттеулер жүргізілген. Нарын құмдары шегінде құмды эол шөгінділерінің жерасты сулары, негізінен, мал суғару, ұсақ елді-мекендерді және мал шаруашылығын орталықтандырылмаған сумен қамтамасыз ету үшін, қолмен қазылған және жабдықталған құдықтар қолданылады. Эолды шөгінділердің жерасты суларының бұрын зерттелген кен орындары пайдаланбайды.

Аймақтық гидрогеологиялық аудандау, тұщы және сәл минералданған сулардың ресурстарын бағалау мақсатында, жалпы геология-гидрогеологиялық көзқарастарға аймақтық маршруттық зерттеу нәтижелеріне негізделген. Ол келесі сулы горизонтардың сипаттамаларын есепке ала отырып орындалған: тиімді сулы горизонттың таралған айналасы; жерасты суыларының жату тереңдігі; сулы горизонттың қалыңдығы; жерасты суыларының минералдылығы.

Нарын құмдарының болжамдық жерасты суларының ресурстарын бағалау ушін оның басты қалыптасу дереккөздері анықталды: табиғи (сыйымдылық) қорлары, табиғи (жаңғыртылмалы) ресурстары.

Ғылыми зерттеу жүрісінде Нарын құмдарының жерасты сулар ресурстарының аймақтық модулдер картасы жасалды. Деректерді өңдеу және карта салуда Geomatica 2016 және ArcGIS 10.5 заманауи геоақпараттық бағдарламалық комплекстері пайдаланды.

Түйін сөздер: кеуектік жерасты суы, Нарын құмдары, Солтүстік Каспий маңы, гидрогеологиялық көрсеткіштер, табиғи қорлары, табиғи ресурстары, гидрогеологиялық аудандау, гидродинамикалық әдіс, болжамды пайдалану ресурстары.

К. М. Канафин[1], И. К. Рахметов[2]

[1]Казахский национальный исследовательский технический университет им. К. И. Сатпаева,
Алматы, Казахстан,
[2]Институт гидрогеологии и геоэкологии им. У. М. Ахмедсафина, Алматы, Казахстан

ОЦЕНКА ПРОГНОЗНЫХ РЕСУРСОВ ПОДЗЕМНЫХ ВОД ПЕСКОВ НАРЫН

Аннотация. Для решения проблем, связанных с водоснабжением сельских населенных пунктов и животноводческих ферм, обводнением пастбищ территории проведены региональные гидрогеологические исследования на территории песчаного массива Нарын в Северном Прикаспии.

Гидрогеологическое обоснование перспективности использования подземных вод заключается в оценке их прогнозных ресурсов. С целью изучения современного состояния поверхностных и подземных вод территории исследований проведены региональные экспедиционные исследования. Подземные воды песчаных эоловых отложений в пределах песков Нарын каптируются в основном колодцами, выкопанными и оборудованными вручную для нецентрализованного питьевого водоснабжения животноводческих хозяйств и мелких населенных пунктов, а также водопоя скота. Ранее разведанные месторождения подземных вод эоловых отложений не эксплуатируются.

Региональное гидрогеологическое районирование с целью оценки ресурсов пресных и слабоминерализованных вод основано на общих геолого-гидрогеологических представлениях, результатах региональных маршрутных исследований. Оно выполнено с учетом следующих характеристик водоносных горизонтов: контур распространения перспективного водоносного горизонта; глубина залегания подземных вод; мощность водоносного горизонта; минерализация подземных вод.

Для оценки прогнозных ресурсов подземных вод песков Нарын определены основные источники их формирования: естественные (емкостные) запасы, естественные (возобновляемые) ресурсы.

Оценка прогнозных эксплуатационных ресурсов подземных вод производилась традиционным и гидродинамическим методами. В качестве традиционных методов оценки использована методология, разработанная учеными Института гидрогеологии и геоэкологии имени У. М. Ахмедсафина.

В процессе научных исследований выполнено построение региональной карты модулей ресурсов подземных вод песков Нарын. Обработка данных и построение карт выполнено с использованием современных геоинформационных программных комплексов Geomatica 2016 и ArcGIS 10.5.

Ключевые слова: поровые подземные воды, пески Нарын, Северный Прикаспий, гидрогеологические параметры, естественные запасы, естественные ресурсы, гидрогеологическое районирование, гидродинамический метод, прогнозные эксплуатационные ресурсы.

Information about authors:

Kanafin K. M. – PhD Student of The Kazakh National Research Technical University after K.I. Satpaev (KazNRTU), km_kanat_2008@mail.ru.

Rakhmetov I. K. – Researcher of LLC «Institute of Hydrogeology and Geoecology named after U.M. Akhmedsafin», issa-92@mail.ru.

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайте:

www:nauka-nanrk.kz

ISSN 2518-170X (Online), ISSN 2224-5278 (Print)

http://geolog-technical.kz/index.php/kz/

Верстка *Д. Н. Калкабековой*

Подписано в печать 30.07.2018.
Формат 70x881/8. Бумага офсетная. Печать – ризограф.
13,4 п.л. Тираж 300. Заказ 4.

Национальная академия наук РК
050010, Алматы, ул. Шевченко 28, т. 272-13-19, 272-13-18