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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
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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.

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THE LAWS OF FORMATION OF GROUNDWATER RESOURCES ON THE TERRITORY OF KAZAKHSTAN AT THE EXPENSE OF SURFACE AND GROUNDWATER

Abstract. The study of hydrogeological structures and the establishment of the relation between surface river water and groundwater. The processes of underground recharging of rivers during the low water season contribute to the preservation of the natural balance of ecosystems, ensuring the normal state of the vegetation cover of the adjacent territories, biota survival and reproduction. The interrelation between surface and groundwater of different geomorphological regions is shown; these regions are represented by mountain, piedmont and flat relief. Regularities in the groundwater formation and the influence of relation to river systems surface runoff on them have been established. Such a relation helps to maintain the ecosystem ecological stability in arid climate conditions, by re-distributing the water runoff of hydrogeological systems with the aquifers of river valleys alluvial deposits. During this period the preservation of water exchange between the groundwater aquifers of river valleys alluvial deposits and overlying water-bearing formations makes it possible to maintain a stable state of the surrounding natural environment due to water exchange. A flow diagram of the interrelation between the individual elements of the water balance of the active water exchange zone (precipitation, water infiltration in the aeration zone, firstly from the surface of the aquifers, sloping on-site and groundwater runoff etc.) is presented for illustrative purposes in this work. Separately, a methodology is given for studying and carrying out quantitative assessment of the interrelation between river and groundwater in the features of the of groundwater runoff formation.

Keywords: surface runoff and groundwater runoff, natural (annually renewable) resources.

Introduction. Regional assessment of the interrelation between surface and groundwater, the objective quantitative indicator of which is the groundwater run-off to the rivers, as well as the reverse process of groundwater recharging due to stream run-off during the spring flood, are of great scientific and applicable merit. The accurate accounting of all components of surface runoff and groundwater runoff of the territories is of great practical importance in arid climate conditions for solving the problems of water supply to the population and economic sectors.

Outstanding scientist V. I. Vernadsky created a harmonious theory about the natural waters of the Earth. Zh. S. Sydykov, member of the NAS RK, wrote the following in his article [1], dedicated to the 150th anniversary of the genius scientist of the twentieth century: "In creating his numerous works on natural waters, he, like no one else before him, used all the vast material and all the preceding experience of science in a better and fuller way in this and related fields, including laws, confirmed by practice and theory."

The three following fundamental interrelated provisions on natural waters is the quintessence of his theory: 1. On the unity of natural (or ground) waters, 2. On the water cycle and the related origin of groundwater, 3. On the energy of natural waters. His following words can be an epigraph when considering the first problem: "All natural waters, wherever they are, are closely related and represent a discrete whole" [2, p. 592]. In the theory of V. I. Vernadsky on natural waters, their internal unity is the main point. Therefore, he considered the water as a whole on a planet-wide scale and emphasized its diversity and location in the earth interior and he also emphasized that ... "In the history of the Earth, natural water "stands apart" among all other terrestrial elements and that there is no natural body that could be compared with its influence on the course of the main, most imposing geological processes" [2, p. 16].

The cycle of natural waters on the Earth is a form of existence and dialectically this process is not somehow closed, and with each new cycle of this process some new transformations take place in the environment. One of the show of the unity of natural waters in the hydrogeological cycle is the interrelation between surface water and groundwater, determining the mutual conditioning of their regime, the dependence of their characteristics on each other [3,4]. The dynamics and magnitude of the groundwater recharging through the aeration zone is related to the difficulty in determining the water balance components, which led the hydrologists to carry out full-scale field investigations because the hydrogeological and hydrological information was insufficient. Therefore, in the 1970s and 1980s field and experimental research in various parts of the Soviet Union was widely developed, and mathematical simulation methods came into using [5-9].

Water exchange in the underground hydrosphere is a process that characterizes the transfer (movement) of natural waters in isolated systems (geological structures) or in their parts, and also from one system (part) to another. This process begins with the groundwater inflow to the aquifer system (or part of it), moving inside and moving out of it into adjacent systems (discharging). Thus, the characteristic components of water exchange in the hydrogeological structure are recharging and discharging of groundwater, which is to say groundwater runoff.

Water exchange in a natural environment is a somewhat arbitrary concept. In recent millennia, mankind has been actively invading the natural surroundings by deforesting, increasing the tilth land for growing crops and obtaining food, in a word, its influence on nature turned out to be so powerful that it led to a change in various elements of the environment, which ultimately affected primarily soil and vegetation cover and deterioration of water exchange conditions.

The water exchange study is carried out in the current period already taking into account the human impact on the natural environment, that have occurred. The variety of natural and anthropogenic factors that determine the formation of the quantity and quality of groundwater, the features and intensity of water exchange, determine the very complex nature of the space-time hydrogeological models of the structures studied.

The water exchange intensity is determined by the mobility of natural waters when moving within the system or part of it. It depends on the boundary conditions, the spacial distribution of parameters and the size of the geofiltration flow. The water exchange intensity integrally reflects the entirety of the listed factors. The quantitative indicators of the water exchange intensity may be the rate of groundwater flow, the groundwater discharge and the duration or rate of water exchange, which is determined by the ratio of the groundwater capacitive resources to the flow rate and reflects the possible conditional time for substitution of groundwater contained in the isolated volume of the system. Hence the following units of measurements are selected: m/day × m^3/year; Flow rate in modular form - $m^3/(day \times km^2)$, $m^3/(year \times km^2)$; rate of water exchange - years.

Different types of water exchange geosystems can be distinguished depending on the research objectives, the nature of the boundary conditions and the structure of the geofiltration medium in the underground hydrosphere. That part of the underground hydrosphere, which is most closely connected with external surface factors of formation, recharging and discharging of groundwater (the zone of intensive water exchange) is of greatest interest for economic use. As it is known, groundwater in natural conditions is the most dynamic component of the lithosphere, and if the ecosystem approach is used, then it is also a component of the ecosystem. Due to its ubiquity, water is also a unique and sensitive indicator of the ecosystem state. If it is in an equilibrium state and the negative factors affecting it are minimal, the ecosystem, taken as a whole, is functioning normally.

However, as a result of the intensification of the human impact on the environment, there are significant changes in the water exchange direction, when the waste of production processes are involved in the turnover, the conditions for the underrun of contaminated surface waters arise, which gradually leads to an increase in negative phenomena in the water-bearing geological environment itself. In this regard, the consideration of those aspects of modern hydrogeology that relate to the most dynamic parts closely associated with surface factors, as well as individual parts of the underground hydrosphere, becomes a new area of studying the conditions for the groundwater formation. The term “water exchange”, which was introduced into the hydrogeological literature by N. K. Ignatovich, B. L. Lichkov, F. A. Makarenko and other researchers, in our opinion, fully and capaciously reflects one of the main properties of natural waters and it has not lost its initial role as an indicator of the conditions for the formation of various types of groundwater.

The general orientation of the lateral water exchange in the water exchange basin is usually observed from the watersheds to river valleys. The degree of equivalence of the configuration and dimensions of river basins and their corresponding water exchange basins depends on the features of the geofiltration medium of the water exchange system, the territory morphostructure, in particular the depth of the cut and the structure of the river valleys of the river basins under consideration and adjacent river basins. Moreover, these conditions are mainly applicable to the uppermost hydrodynamic zone, the so-called active water exchange zone. For deeper horizons, especially artesian waters, the geological feature of the hydrogeological structure, the availability of well permeable reservoirs and the dense argillites dividing them is of paramount importance for water exchange.

Method of study. Conceptually, the diagram of the interrelation between individual elements of the water balance of the active water exchange zone can be represented in the form of the following flow diagram (figure 1).

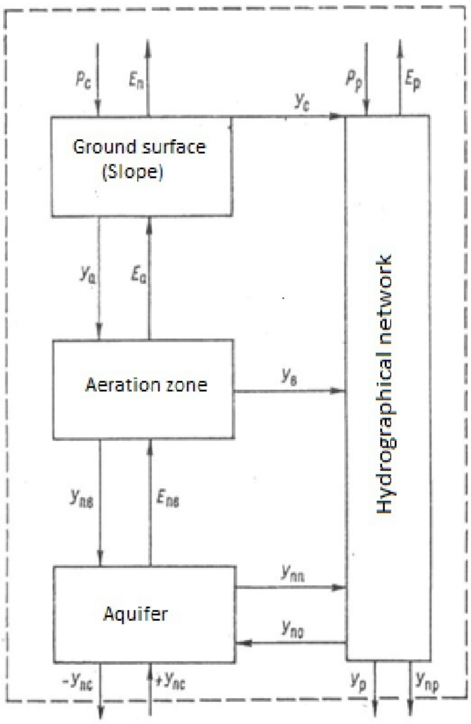

Figure 1 – The interrelation between surface water and groundwater in the hydrological and hydrogeological cycles.

Water balance elements Precipitations: P_l - on the land surface, P_w - on the water surface; evaporation: E_l - from the land surface, E_w - from the water surface, E_a - from the aeration zone, E_{gw} - groundwater (groundwater capillary outflow to the aeration zone); runoff: Y_r - total river, Y_s - slope (surface), Y_a - moisture runoff in the aeration zone (in some cases with the formation of temporary aquifers), Y_{ulgw} - surface runoff and runoff of the upper layer of ground water, Y_{gw} - moisture runoff in the aeration zone for groundwater recharging, Y_{uf} - underground flow into rivers, Y_{uo} - underground outflow of river water for groundwater recharging, Y_{gr} - groundwater runoff of the deep water exchange (minus - outflow, plus + + inflow), Y_{ur} - underflow runoff out of the river basin Arrows indicate the direction of movement of water and moisture, dotted line indicates the border of the river basin. The processes of moisture condensation are not taken into account in the diagram

However, the application of these methods in order to assess the interaction of surface water and groundwater is associated with the need for accurate measurements of all parameters of surface water movement on land, and especially in the channel part of river valleys, as well as in the upper hydrodynamic zone where the first ones flow from the ground surface of the groundwater. Often, in the absence of hydrological and hydrogeological parameters, measured during full-scale studies, it is very difficult to obtain precise quantitative values of this mutual influence.

In the 60-80s of the last century, the Hydrometeorological Service of the USSR and its subordinate Leningrad Hydrological Institute conducted throughout the country the studies of the surface water regime on the observational network and their scientific generalization. The result of this work was the publication of the “Surface Water Resources of the USSR” multi-volume edition, consisting of series: 1. Hydrological exploration degree, 2. Basic hydrological characteristics, 3. Surface water resources. Each series consist of 20 separate volumes, some of which in turn include several issues. Two issues were published in Kazakhstan [10,11]. This monograph combines the materials of two series (the 2-nd and the 3-rd) on the dryland under consideration. And the volume 13 of the issue 1 describes the territory of Central Kazakhstan [12].

The study of the interrelation between surface water and groundwater is a central point in the theory of the formation of land natural waters, so the study of the hydrogeological conditions of any territory will not be complete unless their interrelation is taken into account.

Underground recharging of rivers, basic concepts and common patterns. Underground recharging of rivers consists of a process of the waters of springs, mochezinas running off into the rivers channels; these springs, mochezinas come out either on the surface, or in the bottom parts of the streamflows channels flowing into the main river channel. The amount of underground water entering the river is usually called an groundwater inflow (underground runoff). When assessing the total water balance of the river, this amount is taken as the underground component of the river runoff. At the same time, it is necessary to divide this runoff into so-called "basic", runoff from permanent aquifers and the component from the temporary aquifers, which is as a temporary groundwater inflow (runoff of the upper layer of ground water or soil runoff).

Runoff of the upper layer of ground water and soil runoff refer to the rapidly flowing part of groundwater that takes part in the recharging of rivers only during high water content periods (spring floods, rain floods), and it is usually completely stopped in the low streamflow period. This component of the groundwater runoff is often not taken into account, since the quantitative data on the measurement of these quantities is not available in regional studies and assessments of the water balance of the territories.

The main regularities of rivers recharging in various natural conditions are determined primarily by the discreteness of the showing of the interrelation of river water and groundwater. The latter is associated, on the one hand, with the regime of groundwater runoff in aquifers drained by the river at various hypsometric elevations, and, on the other hand, with the regime of river waters recharging at different positions of the river water level and the groundwater level regime.

At the same time, the levels of aquifers drainage caused by the location of the erosion base level in specific parts of the river valley are of crucial importance in the discreteness of the groundwater inflow. Each erosion base level corresponds to its drainage levels, which determine the limits of uniformity of the regime regularities and the degree of intensity of the underground water exchange.

In general, there are the following according to the drainage conditions within the river basins: the water-dividing sections of the surface watershed area where the permanent aquifers are not drained, but only the formation of a predominant surface slope runoff and the water infiltration for groundwater recharging; and part of the watershed, within which a permanent river system develops, where water exchange between the river and aquifers takes place.

Within the individual drainage levels the discreteness of the underground runoff of the so-called intensive (active) water exchange can also be associated with the location of underground watersheds, which determine the general direction of groundwater movement within the limits of underground watersheds. At that, two types of water objects are distinguished: with coincident and non-coincident surface and underground watersheds.

In terms of the number of drained aquifers, one and multi-layer systems for underground recharging of rivers can be identified, which also determine the discreteness of the groundwater inflow. In conditions of a single-layer system, the underground watersheds practically coincide with the surface watersheds and the boundaries of the latter determine the discreteness of the groundwater inflow of this level of drainage by the local hydrographic network.

In conditions of multi-layered underground recharging systems, the degree of discrepancy between the surface and underground watersheds increases, as a rule, for each subsequent deeper horizon. The degree of discrepancy between watersheds, especially the second and deeper drainable aquifers, should be determined at least roughly from the full-scale data on free and pressure levels of groundwater and from other hydrogeological, geomorphological and geological data. This is especially important in studies in mountain and karst areas, where positive results of work can be determined to a great extent by the objectivity of assessing the correspondence of surface and underground watersheds. The difficulty in determining the actual boundaries of the underground watersheds leads to the fact that in the calculations of river runoff and underground recharging of rivers, the surface watershed area of the river is taken for the underground watershed.

The discreteness of the groundwater inflow within the boundaries of its formation under the influence of this drainage level can be associated with a change in the conditions and degree of hydraulic connection of river water and groundwater. Under the conditions of different hydraulic connection, the direction and water exchange of the river and the aquifers which it drains are dependent on the ratio of river water and groundwater levels in the areas situated near the river channel. The ratio of river water and groundwater levels is determined by the regime of groundwater runoff in the watershed and by the river's level regime and it depends on the morphological structure of the valley, the changes in hydrometeorological conditions in the river basin and it causes the corresponding patterns of intra-annual irregularity in the groundwater inflow, such as the regime of underground recharging of the river.

Method of study. Typification of the basic conditions for the interaction of river water and groundwater can be clearly seen in the diagram (figure 2), which shows the downcutting of the river channel with the water level position, as well as the level surface position. The type of regime of the underground recharging of rivers depends on the ratio of groundwater inflow discharges: Q_r - before the rise of the river water level before the high water (flood), Q_u - the maximum value of the groundwater inflow during the flood period, Qd - with the decline of high water, when the river transits to predominantly underground recharging (the beginning of the low water season).

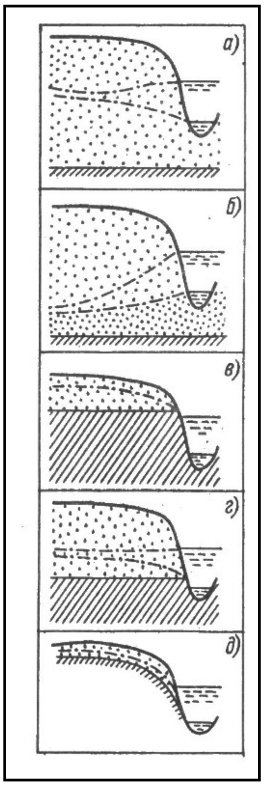

Figure 2 – Typification of the basic conditions for the interaction of river water and groundwater:

a - full hydraulic connection of the aquifer with the river upon the onshore regulation, *b* - full hydraulic connection upon the underground outflow, *c* - lack of hydraulic connection, *d* - periodic hydraulic connection upon high river water levels, *e* - weak hydraulic connection (for example, with a mountain river and etc.)

According to the ratio of these discharges, the following main types of underground recharging of rivers can be identified (figure 2). The type of the descending (free) underground recharging of the river (see figure 2*a, b*) is typical for the following conditions: 1) lack of hydraulic connection of rivers with aquifer; 2) under the conditions of hydraulic connection, when backing of groundwater by the river waters in the near-river zones has a weak or short-term effect (see figure 2*c, d*).

The type of retained underground recharging of the river (figure 2 *c, d*) is typical for conditions when, during hydraulic connection of the river with the aquifer, the rise in the river water level leads to the backing of groundwater in the near-river zone and the development of so-called bank storage, which is the river water filtration into the banks at the ascending stage of high water (flood) and their return to the rivers with the decline of high water.

The intra-annual irregularity in the groundwater inflow reflects the dynamics of groundwater runoff in the watershed, determined by the uneven recharging of groundwater. Due to the significant overregulation of the groundwater runoff, the maximum discharges of the groundwater inflow may be somewhat delayed relative to the flood peak. (see figure 2*a*) or coincide with the end of the flood, when the river transits to predominantly underground recharging (see figure 2*b*).

In conditions of hydraulic connection of the river with aquifers, when during high water periods (floods) there are synchronous and definitive changes in the level of river water and groundwater in the riverain zone or the rise in the level of the latter occurs more intensively, there will also be a descendent movement and recharging of the river.

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The practice of studies of groundwater runoff and underground recharging of rivers indicates that when using the methods of the listed groups, the most correct solution can be obtained only on the basis of the using the results of a joint analysis of hydrometeorological and hydrogeological information on the water regime and the natural features of the studied object. Thus, the connection of surface water and groundwater as a determining factor in the formation of annually renewed groundwater resources in arid regions is a very important component that allows for the assessment of groundwater resources in Kazakhstan.

Water exchange in natural aquifer system serves as a qualitative and quantitative basis for solving various hydrogeological and hydroeconomic problems of a research, methodological and applicable nature. The diversity of natural water exchange geosystems predetermines the diversity of the space-time forms, intensity and scale of water exchange. The complexity of the water exchange structure, imposing different space-time elements on each other, are determined depending on the problem being solved and the specific hydrogeological conditions of the object. Depending on the scope of the study, individual forms may be excluded from consideration or simplified in space and time or water exchange elements. The water exchange research strategy should be based on a system of various scales models, including detailed site models, local fragment models and regional models that provide background research for the target solution. The following time periods can be investigated: days, seasonyears, long-time average annual periods of time.

Key (reference) sites of detailing are important in the construction of regional models, which allow to identify and study the basic parameters and patterns of water exchange that determine the principles and details of extrapolation of their reference values in time and space. Such a combination of various scales models allows to solve more objectively the questions on the permissible degree of the model simplification and the corresponding errors of the solutions obtained. The questions of permissible averaging of individual parameters, choice of methods of study, scopes and types of research are also solved on the basis of the carried out evaluation of the optimal degree of space-time schematization.

Three following areas can be distinguished in the development of the theory of the groundwater formation in Kazakhstan: 1) development of methods for studying and mapping the processes of groundwater resources formation; 2) general theoretical problems of regional distribution of groundwater and generalizations of their formation and accumulation; 3) detailed study of individual regions and the most promising and water-rich types of groundwater. The first two directions made it possible to create a complex of hydrogeological maps and to prepare a basis for showing the most important hydrogeological, geomorphological, climatic and other features of the accumulation of the water mass of aquifers and complexes of hydrogeological structures.

Based on the results of these studies, a whole series of survey hydrogeological maps was prepared and published for the first time for the arid territory of Kazakhstan, a list of which we have shown in the list of cited references.

The maps show the variety of conditions for the groundwater resources formation on the territory of the republic, the presence of numerous promising structures and aquifers, and the regularities in the groundwater deposits distribution have been assessed and clarified. These works have disproved the mistaken opinion that Kazakhstan's subsurface resources are poor with fresh water and at the same time revealed 70 artesian basins, numerous groundwater flows with huge so-called "age-long" (7.5 trillion m^3) and annually renewable (48 billion m^3) resources, and established their operational capabilities in the volume of 1960 m^3/s.

The results of the hydrogeological survey subsequently showed that this approach greatly facilitated the identification and exploration of new groundwater deposits for various needs, significantly increasing their effectiveness. Thus, the widespread use of groundwater for water supply to the population and various economic sectors has become yet another confirmation that Kazakhstan's subsurface resources contain a sufficient number of pathogen-free groundwater that can become a reliable reserve of the country's water resources in the absence of the necessary interstate agreements and joint legal documents governing their sharing.

A brief outline of the history of the development of the groundwater formation theory in Kazakhstan shows that it is constantly developing and is filled with new content that takes into account not only the specific features of Kazakhstan's territory, but also the global trends that take into account the ecological component, as well as global processes in the climate change and the water resources cycle on the Earth. Scientists and specialists from Kazakhstan's neighbouring countries note a consistent and systemic approach, which is proposed to be solved taking into account the mutual interests by the Kazakhstan party, while de jure an agreement is still not reached in interstate relations on the use of transboundary water resources. In this issue, Kazakhstan advocates for the use of a world or at least a European practice of water apportioning in each drainage basin. It is sufficiently well developed and adherence to its provisions would help to avoid conflict situations and contribute to the preservation of ecological stability in these transboundary areas.

The groundwater formation problem includes a number of controversial and contradictory concepts and provisions, interpreted in different ways. For example, there is no unambiguous interpretation of the problem of the primary source of the Earth's hydrosphere. Either it appeared simultaneously in the period of particles accretion from a dust-gaseous nebula, among which water was also present in the form of ice crystals. Either it was separated from the protoplanetary substance itself over a long period of terrestrial substance differentiation over a certain period of the Earth's life.

A number of controversial questions concern the definition of the subject of hydrogeology, which was often associated in the past with hydrology, the science of the land waters. Later, when as a result of drilling deep wells, hydrogeologists discovered groundwater in super-deep wells and could determine their absolute age, gave an explanation of their chemical composition and the water-soluble substances, incl. gases contained in it, hydrogeological science has acquired all the necessary attributes as an independent science on the Earth's underground hydrosphere. Thus, hydrogeology is now an integral part of the series of Earth sciences, entering into a number of fundamental sciences.

Conclusions. Thus, it can be stated that the regional assessment of the interaction of river waters and groundwater requires the use of additional hydrogeological and hydrological information obtained on normal profile and gauging stations. For arid regions an estimate of the underground outflow of river waters is very important, since most of the time of the year the rivers are recharged by the underground aquifers. But, during the onset of the so-called "dry time", when the air temperature begins to rise and atmospheric precipitation ceases, the rivers transit to underground recharging by discharging them into deep reaches. This situation has a very positive effect on the saving of river biota and the ecosystem as a whole.

It also follows from the above that in the arid conditions of Kazakhstan the underground outflow of river waters plays its positive role in the general cycle of water resources. Therefore, when using river water and groundwater, it is necessary to constantly monitor the development of these processes through monitoring and take timely measures to prevent excessive withdrawal of both the surface and underground component of the water flow of any territory. In the typification of underground outflow of river waters, the following are distinguished: a). Temporary (seasonal) outflow. This type is characterized by coastal infiltration, as well as periodic losses to the karst cavities. b). Constant outflow. The groundwater recharging from the river channel with the occurrence of aquifers below the river level. It is a very characteristic phenomenon for rivers in countries with arid climate, as well as for some mountain rivers and areas where karstic rocks are developed. This type is also characteristic for river valleys, which cut through inclined water-permeable layers in their geological structure and losses of river water occur in one bank, along the slope of the aquifer. But the underflow runoff is the most frequent form of river water outflow. Almost all major rivers of Kazakhstan for a large part of the valleys have a constant underflow runoff.

As researches have shown, the initial hydrological and hydrogeological information serves as a basis for an objective assessment of the features of the interrelation of surface river water and groundwater. The list of basic hydrogeological information consists of the following data:

1. the general characteristic of the hydrological exploration degree of the territory is needed;

2. the characterization of the drained aquifers distribution according to the lithologic and stratigraphic characteristics and general physical and geographical conditions;

3. the information on the location of surface and groundwater watersheds in different parts of the watershed area of the main river and its tributary streams;

4. the characteristic of underground recharging of rivers in separate sections of the river basin with respect to the number of drained aquifers and the degree of their participation in the formation of an underground tributary stream.

5. the information on the features of the hydraulic connection between river waters and aquifers drained by the river;

6. the characterization of the intra-annual irregularity of groundwater runoff in the watershed, primarily in relation to its discreteness, depending on the lithologic and stratigraphic features of the drained aquifers and their water regime;

7. the information on the relationship between the amplitudes and rates of changes in the groundwater level in the near-river zone and river waters to determine the possibility of bank storage developing and calculating the dynamic amplification factor of the groundwater inflow to the river under conditions of the bank storage;

8. the quantitative characteristics of the coefficients of intra-annual dynamics of groundwater runoff in watersheds and groundwater inflow to the rivers based on the results of full-scale observations, by hypothesis or established by expertise on the basis of analysis of materials obtained in previous studies.

When generalizing hydrogeological information for calculations of the groundwater inflow to the rivers, it is advisable to use the principles and methodology of schematization of hydrogeological conditions, which are usually used in modeling in hydrogeology [9, 13, 32, 33, 38].

When assessing the groundwater inflow to the rivers, the hydrological information is used for the solution of the following main tasks:

1. the general characteristics of the hydrological exploration degree of the water body;

2. the determination of the hydrographic network structure and the connection of its structure with the discreteness of the groundwater inflow to the rivers at various levels of drainage of aquifers and complexes;

3. the establishment of the compliance of the hydrometrical section location with data on the low runoff of the actual discreteness of interaction between river water and groundwater within the study area;

4. the determination of typical water discharges in the period of low runoff at representative hydrometrical sections in order to calculate the total groundwater inflow to the rivers within the watershed above the measuring section line;

5. the obtaining of regime data on water levels in rivers under conditions of hydraulic connection between river water and groundwater in order to assess the intra-annual irregularity in the groundwater inflow to the rivers and in order to determine the possible degree of bank storage development in years of different water content.

General information on the river basins of the study area, climatic data, characteristics of the regime of surface water and groundwater, the hydrological regime of rivers and the river basins water balance, the minimum runoff and other data necessary for calculations of water regime elements. A great help in collecting hydrological information can be provided by new “Water resources of Kazakhstan: estimation, forecast, management” monographs, consisting of 21 volumes and published in 2012 by the Geography Institute of the RK. Two of which were used by us when writing this report [32, 33].

In conditions of weak hydrological exploration degree of the territories and the complex hydrogeological structure of the groundwater basins, it may be necessary to carry out occasional measurements of water discharge at key river stations during the periods of low water season, over which it will be possible to determine the design characteristic calculation. N.S. Ratner developed a very acceptable method for calculating the characteristics of the groundwater inflow to the rivers according to data of direct measurements of the water discharge of rivers during the periods of low water season [39].

Recommendations for improving the accuracy of occasional measurements of water discharge in the plain and mid-mountain areas, as described in the works of the SHI (State Hydrological Institute), are very useful [17, 19, 23-25, 39]. Details of the organization and carrying out of hydrometrical surveys (content, periods and methods of conducting hydrometrical operations, primary processing of the results obtained) are considered in methodological recommendations [17, 39, 41]. Methods of carrying out experimental work and processing their results are described in vast domestic and foreign literature. Among others there is a significant number of publications highlighting the features of the methodology for conducting the testing for groundwater inflow in the study of the conditions of the interrelation between the groundwater and surface water [42].

Concluding consideration of the problem of the interrelation between the surface water and groundwater, it is necessary to highlight its importance both from the scientific and from the practical aspects. In this regard, it is worth recalling that little attention was paid to this problem in previous years. For example, publications on the surface runoff of the rivers of Kazakhstan are quite sufficient by now, which can not be said about the hydrogeological aspects of the interrelation between the surface and underground runoff. The authors of this report found only a few works devoted to this problem [43-48]. Studies in this important area should be expanded.

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ЖЕР ҮСТІ ЖӘНЕ ЖЕР АСТЫ СУЛАРЫ ЕСЕБІНЕН ҚАЗАҚСТАН АУМАҒЫНДА ЖЕР АСТЫ СУЛАРЫНЫҢ РЕСУРСТАРЫН ҚАЛЫПТАСТЫРУ ЗАҢДАРЫ

Аннотация. Гидрогеологиялық құрылымдарды зерттеу және жер үсті және жер асты суларының арасындағы қатынастарды орнату. Түрлі геоморфологиялық аймақтардан жер үсті және жер асты сулары арасындағы байланыс көрсетіледі; Бұл аймақтар таулы, тау бөктерінде және тіпті рельефте ұсынылған. Жер асты суларының қалыптасуын реттейтін заңдар және оларға өзен жүйелерінің үстіңгі ағынының әсері белгіленді. Бұл қатынас құрғақ климаттық жағдайда экожүйенің экологиялық тұрақтылығын сақтауға, гидрогеологиялық жүйелердің су ағындарын өзен алқаптары шөгінділерінің аллювиальды шөгінділерімен қайта бөлуге көмектеседі. Осы кезеңде өзен алқаптары мен үстіңгі сулы қабаттың аллювиалды шөгінділерінің жер асты сулы қабаттары арасындағы су алмасуды сақтау су алмасу арқылы қоршаған ортаның тұрақты жағдайын сақтауға мүмкіндік береді. Бұл жұмыста иллюзивті мақсаттар үшін активті су айырбастау аймағының су балансының жекелеген элементтері арасындағы байланыстың блок-схемасы (жауын-шашын, аэрация аймағындағы судың енуі, ең алдымен сулы қабаттың бетіндегі, көлденең далалық және жер асты дренаж және т.б.) берілген. Жерасты суларының ағынын қалыптастырудың ерекшеліктерінде өзен мен жер асты суларының арасындағы қарым-қатынастарды сандық бағалауды зерттеу және жүргізу әдіснамасы бөлек беріледі.

Түйін сөздер: жер үсті суларының ағысы мен табиғи ағыны, табиғи (жыл сайын жаңартылатын) ресурстар.

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ЗАКОНЫ ФОРМИРОВАНИЯ РЕСУРСОВ ПОДЗЕМНЫХ ВОД НА ТЕРРИТОРИИ КАЗАХСТАНА ЗА СЧЕТ ПОВЕРХНОСТНЫХ И ПОДЗЕМНЫХ ВОД

Аннотация. Изучение гидрогеологических структур и установление связи между поверхностными речными и подземными водами. Показана взаимосвязь между поверхностными и подземными водами разных геоморфологических регионов; эти регионы представлены горным, предгорным и ровным рельефом. Установлены закономерности формирования подземных вод и влияние на них поверхностного стока речных систем. Такое соотношение помогает поддерживать экологическую устойчивость экосистемы в засушливых климатических условиях, перераспределяя водный сток гидрогеологических систем с водоносными горизонтами аллювиальных отложений речных долин. В этот период сохранение водообмена между подземными водоносными горизонтами аллювиальных отложений речных долин и вышележащими водоносными образованиями позволяет поддерживать стабильное состояние окружающей природной среды за счет водообмена. Представлена блок-схема взаимосвязи между отдельными элементами водного баланса активной зоны водообмена (осадки, инфильтрация воды в зоне аэрации, в первую очередь с поверхности водоносных горизонтов, наклонные полевые и подземные стоки и т. д.) для иллюстративных целей в этой работе. Отдельно дается методика изучения и проведения количественной оценки взаимосвязи между рекой и подземными водами в особенностях формирования стока подземных вод.

Ключевые слова: поверхностный сток и сток подземных вод, природные (ежегодно возобновляемые) ресурсы.

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REFERENCES

[1] Sydykov Zh.S. The main provisions of academician V.I. Vernadsky's theory on natural waters // Proceedings of the NAS RK. Series of geology and engineering sciences. 2013. N 1. P. 84-89.

[2] Vernadsky V.I. Selected works. Vol. IV, the second book. M., 1960. 653 p.

[3] Shestopalov V.M., Sitnikov A.B., Lyalko V.I., et al. Methods of studying water exchange // In the book “Water exchange in hydrogeological structures of Ukraine”. Kiev: Nauk. dumka, 1988. 272 p.

[4] Shestopalov V.M., Sitnikov A.B., Lyalko V.I., et al. Water exchange in natural conditions // In the book “Water exchange in hydrogeological structures of Ukraine”. Kiev: Nauk. dumka, 1989. 288 p.

[5] Antontsev S.N., Epikhov G.P., Kashevarova A.A. System mathematical simulation of water exchange processes / Ed.-in-chief P. Ya. Polubarinova-Kochina. Novosibirsk: Nauka, SB (Siberian Branch) of the USSR AS (Academy of Sciences), 1986. 215 p.

[6] Epikhov G.P. Mathematical simulation of planned filtration in interrelation with river runoff and its implementation // Water resources. 1980. N 2. P. 35-44.

[7] Sokolov V.G. Mathematical formulation of the problems for interaction of surface water and groundwater // “Problems of hydrology” collected volume. M.: Nauka, 1976. P. 128-139.

[8] Vsevolozhsky V.A., Dyunin V.I., Gurova N.N. Studies of artesian structures groundwater runoff // Interaction of surface and groundwater runoff. 1976. Issue 4. P. 45-57.

[9] Gavich I.G. Theory and practice of applying mathematical simulation in hydrogeology. M.: Nedra, 1980. 358 p.

[10] Resources of surface waters of the USSR. Vol. 12. Lower Volga region and Western Kazakhstan. Issue 3. Aktobe region. L., 1966. 515 p.

[11] Resources of surface waters of the USSR. Vol. 12. Lower Volga region and Western Kazakhstan. Issue 2. Ural-Emba region. L., 1966. 515 p.

[12] Resources of surface waters of the USSR. Vol. 13. Lower Volga region and Western Kazakhstan. Issue 1. Central Kazakhstan. L., 1966. 515 p.

[13] Shestopalov V.M. Methodological aspects of studying water exchange in hydrogeological structures // Water exchange in hydrogeological structures of Ukraine. Kiev: Naukova Dumka, 1988. 272 p. (P. 8-52).

[14] Kudelin B.I. Principles of regional assessment of groundwater natural resources. M.: MMU (Moscow Mining University), 1960. 344 p.

[15] Groundwater runoff in the territory of the USSR. Under the editorship of B. I. Kudelin. MMU, 1966. 303 p.

[16] The runoff of Kazakhstan's groundwater. Alma-Ata, 1964. 86 p.

[17] Hydrometrical assessment of the interaction of river water and groundwater (temporary methodological recommendations). L.: SHI, 1973. 77 p.

[18] Regional assessment of underground recharging of the USSR rivers // Proceedings of the SHI. 1968. Issue 154. 175 p.

[19] Popov O.V. Use of hydrological information in forecasting groundwater resources // Methods for analysing and processing hydrogeological data for forecasting groundwater resources. Tallinn: the ESSR AS, 1984. P. 85-91.

[20] Karasev I.F. River hydrometry and water resources accounting. L.: Gidrometeoizdat, 1980. 310 p.

[21] Kritsky S.N., Menkel M.F. Methodical base of water management balances construction // Proceedings of the Hydroproject. 1964. Collected volume 12. P. 29-62.

[22] Investigation of underflow runoff in water balance studies (methodological recommendations). L.: SHI, 1968. 42 p.

[23] Methodical instructions of TAHEM (Territorial Administration for Hydrometeorological and Environmental Monitoring). N 89. River basins water balances analyses. L.: Gidrometeoizdat, 1974. 96 p.

[24] Methodical instructions of TAHEM. N 90. Channel water balances analyses. L.: Gidrometeoizdat, 1977. 103 p.

[25] Methodological recommendations on accounting for the economic activity impact on the small rivers runoff in hydrological calculations for hydroeconomic design. L.: Gidrometeoizdat, 1986. 167 p.

[26] Kudelin B.I. To the method of determining the underground recharging of rivers // Reports of the USSR AS. 1950. Vol. 52, N 1.

[27] Kudelin B.I. Coastal regulation of surface runoff // Reports of the USSR AS. 1950. Vol. 21, N 1.

[28] Makarenko F.A. On underground recharging of rivers // Proceedings of the LGP (laboratory of hydrogeological problems) named after F. P. Savarensky, member of the USSR AS. 1948. Vol. 1.

[29] Kudelin B.I. Groundwater runoff in the territory of the USSR. M.: MMU Publishing House, 1966. 303 p.

[30] Amusya A.Z., Ratner N.S. To the territory zoning under the conditions of interaction of surface water and groundwater in the water balances analyses // Water resources. 1985. N 1. P. 47-56.

[31] Water resources of Kazakhstan (Surface and groundwater, current state). Reference book. Almaty: “Gylymм” SRC, 2002. 596 p.

[32] Water resources of Kazakhstan: estimation, forecast, management. Group of authors. Vol. VII, book 1. Almaty, 2012. 684 p.

[33] Water resources of Kazakhstan: estimation, forecast, management. Group of authors. Vol. VII, book 2. Almaty, 2012. 360 p.

[34] Sydykov Zh.S., Mukhamedzhanov M.A. Underground water and chemical runoff of the active water exchange zone of the Peri-Caspian Depression // Proceedings of the NAS RK. Geological series. 2006. N 5. P. 77-84.

[35] Sydykov Zh.S., Mukhamedzhanov M.A. Groundwater and salt runoffs of the Lake Balkhash basin // Proceedings of the NAS RK. Geological series. 2009. N 6. P. 52-56.

[36] Formation of groundwater runoff in the territory of Kazakhstan. Group of authors. Alma-Ata: Nauka, 1970. 147 p.

[37] Sydykov Zh.S. Groundwater runoff in the territory of Aktobe Semirechie // Proceedings of the NAS RK. Series of geology and engineering sciences. 2012. N 4. P. 48-49.

[38] Minkin E.K. Interrelation of groundwater and surface waters and its importance in solving some hydrogeological and hydroeconomic problems. M.: Stroyizdat, 1973. 103 p.

[39] Ratner N.S. The use of hydrometrical information for the regional assessment of the interaction of river water and groundwater // Proceedings of the SHI. 1981. Issue 272. P. 10-24.

[40] Materials of the interdepartmental workshop on the method of hydrometrical assessment of groundwater runoff to the rivers (Valdai, June 15-19, 1965). Valdai, SHI, 1966. 230 p.

[41] Petrov G.N. Low streamflow runoff and its study // Proceedings of the Kazan branch of the USSR AS. Ser. Energy and Water Management. 1956. Issue 1. 144 p.

[42] Shestakov V.M. Groundwater dynamics. M.: MMU Publishing House, 1973. 327 p.

[43] Grinberg S.V., Osipova A.N. On underground recharging of mountain rivers of the Zailiysky Alatau northern slope // Proceedings of the Kazakhstan SSR AS. Geological series. 1963. N 5. P. 89-95.

[44] Shlygina V.F. Groundwater runoff from the Zailiyskiy Alatau northern slopes and its role in the alluvial cone groundwater recharging // Proceedings of the Kazakhstan SSR AS. Geological series. 1964. N 4. P. 48-62.

[45] Dzhakelov A.K. To the methodology for determining the groundwater deep runoff formed in the mountain-folding regions (for example, the Zailiysky Alatau) // Proceedings of the NAS RK. Geological series. 2007. N 6. P. 73-86.

[46] Overview. Water resources of Kazakhstan in the new millennium. Almaty, 2004. 132 p.

[47] Development of water balance in the basins of rivers Big and Small Uzeni; Scientific report of the Uralvodproekt LLP. Uralsk, 2002. Book 2. 263 p.

[48] Mukhamedzhanov M.A., Sagin Jai, Kazanbaev L.M., Rakhmetov I.K. Relation between surface water and groundwater as the factor for formation of groundwater renewable resources on the territory of Kazakhstan // “Izvestiya” National Academy of Sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. 2018. Vol. 5, N 431. P. 15-17. https://doi.org/10.32014/2018.2518-170X.1 ISSN 2518-170X (Online). ISSN 2224-5278 (Print).

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