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Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

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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.

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M. A. Mukhamedzhanov[1], Jay Sagin[2], T. A. Rakhimov[1], Y. O. Arystanbaev[1]

[1]Satbayev University, Ahmedsafin Institute of Hydrogeology
and Environmental Geoscience, Almaty, Kazakhstan;
[2]University of Saskatchewan, Saskatoon, Canada.
E-mail: muratmukhamtd09@rambler.ru, jay.sagin@usask.ca,
t-rakhimov@mail.ru, yarystan47@mail.ru

DEVELOPING SCENARIOS OF SUSTAINABLE WATER-SUPPLY FOR KAZAKHSTAN POPULATION AND ECONOMY UNDER CLIMATIC AND ANTHROPOGENIC CHANGES AT THE REGIONAL, NATIONAL, AND TRANSBOUNDARY LEVELS UNTIL 2030

Abstract. Principle of method is in the analysis of external environment for key factors and their combining for creating alternative development scenarios. Alternatives formed in the scenario approach allow identifying an aggregate of possible directions of environment development and thus create a basis for making strategic decisions. This paper considers theoretical and methodological basis of scenario planning, including various approaches and methods of scenario formation. Experience of this method application in Kazakhstan and abroad was studied.

The paper identifies natural factors affecting water-supply conditions. Advisability of forming external environment development scenarios was justified for further development of alternative strategies for hydrogeological survey improvement. Based on the algorithm of forming and transboundary levels until 2030 of the proposed principles, scenarios were developed for creating plans of sustainable water-supply under conditions of climatic and anthropogenic changes at the regional, national and transboundary levels.

In order to develop strategies and scenarios, as well as to identify vulnerabilities and negative impacts of climate change, it is necessary to have complete information and data on the entire basin. Therefore, it is necessary to collect and share the necessary information, data and models related to the basin as a whole, as well as all components of the water cycle. Managing the process of adaptation to climate change, it is necessary to monitor the situation and regularly update assessments, climate change scenarios and forecasts of the state of the water balance.

Climate change should be considered as one of the main causes of changes in the environment of water basins, and as one of the many factors that put pressure on water resources. Therefore, adaptation scenarios for specific basins should take into account not only climate change, but also changes in the demographic situation, economic growth dynamics, dietary preferences, and so on. These scenarios should be developed with the greatest possible cooperation with neighboring countries, and most importantly, using data and models that are consistent with them.

Key words: Scenarios method, external environment factors, strategy, alternative scenario.

Introduction. One of main tools actively used for the development of strategy in the past three decades by the majority of western companies is the scenarios method. For today, there is no a concurrent view on identification of the term “scenario planning”. Different researchers give their own interpretations of the notion. From quoted identifications of many authors one can conclude that a scenario is deferent from a forecast (description of comparatively predictable progression of events in the present) and is not a projection – desirable future that a company endeavors to achieve. Forecasts and projections conceal risks, scenarios on the contrary, make risk management possible. Scenarios are a qualitative description of a situation containing individual quantitative estimates. This is their difference from forecasts where emphasis is made on quantitative indicators as a rule. Scenario planning represents not only the development of a company development scenarios, it is closely connected with strategic planning. Thus, a

scenario is a description of a vision of the future comprising interconnected factors, with different probability leading to predictable status of the conditions under study in the future.

Scenarios development. This stage includes: selecting of influencing factors; forecasting different results of scenarios; combining significant factors and scenarios forming. While selecting factors, it is recommended to rest upon the results of external environment analysis, to identify the most significant factors that will be the basis for the scenarios. As a method applied at this stage with the purpose of identifying the most significant factor. The stage must result in the selection of several most significant and independent factors.

Fundamentals of scenario planning. Under conditions of the area of water supply to population and the country economy, important is forecast of development of so-called scenario forecasting and development of practical recommendations taking into account existing environmental and anthropogenic conditions of the territories. Scenario planning helps managers get adapted to various versions of events in the area of wide groundwater use, have certain specific solutions and alternative options of developments.

Within the framework of scenarios, incoming general economic preconditions, economic factors of territories development level and government regulation, socioeconomic development, status of level of water supply hydrogeological conditions can be considered. Theoretical aspects of strategic management with considering of scenario planning toolbox, strategic and comparative analysis were taken as the methodological basis for scientific research.

Development of practical recommendations for drinking quality groundwater prospected resources sound management has special importance. Especially important this status should be taken into consideration under conditions of arid climate and water resources deficit. There are various approaches to identifying such notions as “scenario” or “scenario planning” among scientists in the area of strategic management. So Michael Porter is of opinion that the scenario planning (SP) should be represented as “inner consistent view of what the future can face about” [1]. Piter Schwartz gave the following definition to SP: “A tool for ordination of existing representations about possible conditions of activities in the future, where a decision made turns out to be a correct one” [2]. Jill Ringland believed that SP is “an element of strategic planning founded on methods and technologies of managing the uncertainties of the future” [3]. Paul Schoemaker identified SP as “a rational method to present possible options of the future where decisions made by the organizations may be executed” [4]. Scenario planning includes not only scenarios forming but also a set of managerial decisions, actions and activities within the framework of strategic planning [5].

A scenario is a vision of prospects that look like a population of events coordinated and logically mutually associated with a specific algorithm of actions which describes and gives details of the forecasted status of a system – object of the strategic planning in the future. Most often, scenarios represent a projection of qualitative nature, and here, some most important quantitative estimates are acceptable and necessary. Thus, SP is different from forecasting where emphasis is made on a multitude of justified indicators of quantitative nature.

SP is used in branches of economy, at enterprises and their strategic business units while evaluating environment macroeconomic factors and raw materials markets. Scenario method is useful in definition of the organization objectives, identification of development strategy, and also in long-term forecasting, when current achievements lose their importance and significance of new possibilities application grows. Theoretical aspects of strategic planning with consideration of scenario planning toolbox, strategic and comparative analysis were taken as a methodological basis of the scientific research.

In SP, H. Kahn rests upon dynamics of qualitative indicators using retrospective approach of macro-historic functioning and the system development. Thus, scenarios go from a hypothesis to facts. And as a result, scenarios, according to H. Kahn, are a hypothetic sequence of events used for studying cause-effect relations and leading to making strategic decisions [6].

Fresh groundwater as a part of mineral resources sector may be presented as a dynamically developing socioeconomic system comprising a number of sub-industries. Each option of mineral resources sector (MRS) development scenarios records certain dynamics of production development and change in processing volumes formed on the basis of combination of possible development conditions. Scenario approach allows consideration of all diversity of macroeconomic and technological conditions. Aggregative country or region groundwater resources efficient use development options alternatives in the

majority of cases is enough to describe on the basis of three scenarios – inertial, evolutional and innovative.

In the part of ensuring favorable ecological situation, it is advisable to provide for in:

– the area of water sound management: construction and improvement of waterworks and treatment facilities, reduction of surface and underground water bodies pollution with waste water and hazardous substances arriving from urbanized and agricultural areas; providing population with clean drinking water;

– the area of land resources protection and use: ensuring complex approach to land (soil) use and protection for its sustainable management;

– the area of forest resources protection and use: ensuring stable functioning of forest ecosystems, preservation of forest biological and genetic diversity, increasing of ecologic-economic strength of the economy forest sector;

– the area of waste management: prevention or minimization of wastes generation at account of introduction of low- and waste-free technologies;

– the conservation of biological diversity, specially protected natural areas network optimization [7];

Water consumption growth which in the long term will become the main threat will occur under influence of both climatic peculiarities including temperature increase, as well as a consequence population pressure. To meet the need in foodstuffs and municipal needs, the humanity will need additional water resources, which according to data of Food and Agriculture Organization of the United Nations (FAO) by the mid-century will amount 70% of the current consumption level. Today, more than 1 bln people do not have access to clean drinking water, 2 bln – to wastewater disposal systems, 920 mln starve. To satisfy their needs and needs of another 2-2.5 bln new inhabitants of the planet, it will be necessary to add to current 4,200 km^3 of water extracted from water sources, by almost 3,000 km^3 more. This means that the humanity will encroach on those 9,000 km^3 that still retain ecological natural value of water. Accordingly, irrespective of the increase or decrease in surface water, areas with poor water supply destined for increasing water deficit due to implacable water use growth [8].

Thus, it is necessary to search for additional sources of water and increase the productivity of available water resources. Right now it is difficult to forecast the extent of consumption increase in connection with temperature increase, change in air humidity, demographic transitions. But it is apparent that with the current unpredictability of all these changes, it is necessary to align water use mechanisms and tools with economic use of resources available to people.

Water survival mechanisms. Transition to water resources integrated management allows curtail water resources deficit drastically at account of public participation, integration of science and production, combining interests of various industries (horizontal integration), linking levels of water hierarchy and elimination of organizational losses on their junctions (vertical integration), and also engaging other water sources. This method has been applied and is still applied for centuries in Spain, Italy, France.

Water resources integrated management is based on several fundamental principles:

– basin hydrographic management, which means building of organizations responsible for supply of water, along its stream “top-down” with minimizing losses on junctions of water hierarchy and non-admission of administrative interference;

– public participation of all water-users, which mean active involvement of non-governmental organizations of water-users and water-consumers into top-down management on principles of parity with the right of decisive vote and participation in financing;

– recording and inclusion of all types of water;

– combining interests of all industries and enterprises of water use;

– water saving;

– priority consideration of nature requirements;

– financial stability.

Creation of a clear and well-controlled system of water resources management. Water economy of Israel (for arid area), water economy of the Netherlands (for coastal areas and areas of excessive humidity in general) and water economy of Switzerland (for moderate landscapes with intensive level of urbanization development) can be prototypes of future water management systems. For all above-listed countries, characteristic is reverence to water as the basis of natural complex that has a tremendous ethical, cultural and moral potential [9].

Natural and anthropogenic systems in these countries are closely interlaced. Here is a centralized public water management top-down identifying the order of distribution, limiting, monitoring of water resources and their use with direct management top-down with wide involvement of all stakeholders. The procedure set by the state for financing, interest of water-users and water organizations in water-saving, guarantees sufficient funds for maintaining, improvement and development of facilities with participatory interest of the state, but with a wide application of principles "user pays" and "polluter pays" (payment is higher as higher the use and pollution). All hydroeconomic and reclamation systems comply with the high technical level, are automated, equipped with on-line control, emergency forecasting and warning system. By level of productivity they are getting close to potential water productivity [10].

Water economy by the end of XXI. It is possible to suggest that by the end of XXI century, high technical level of future water economy systems will be ensured at account of the following components.

1. One hundred percent keeping record of all types of water (from basin main sources to the last discharge outlet to a user, including all groundwater - their intake from wells, attenuation) and their regular balancing on-line with SCADA systems. Such record-keeping will be accompanied by a dense network of climate stations recording and transmitting to end-users and water organizations the data allowing them with the use of programs available to them to adjust water consumption, mode of use and water distribution plan. SCADA systems that have been used for almost ten years (for instance in the Basin hydroeconomic association Syrdarya in Central Asia), ensure precision of water measurements and water supply ± 2% with comparatively low cost. Climatic maintenance systems are very well tuned up in Canada, Israel, and a number of water districts of western U.S.

2. Well set up service of hydrological, climatic and reclamative forecasts with emphasis to forecast of emergencies based of computerized program of satellite and ground tracking, information and warning. Such services are operating successfully today in Korea and the Netherlands. In the Netherlands, the service controls emergency mode of flood control works of the highest technical level – closing riverbeds from the possibility of incoming of upsurge waves from the sea, operation of pump out houses, as we'll as complex networks of excess water entrapping and diversion [11].

Water supply and consumption in cities and rural areas will be ensured based on established regional norms both for quality and quantity as a mandatory prerequisite for residential zones functioning. Other needs will be satisfied (as in Israel) at account of service water use systems from unpolished, but permitted effluents or brakish water. All municipal effluents will be collected, treated and sent via water ducts, depending on treatment extent, to satisfy production needs, for watering of municipal and township plants, sanitary service of built-up centers. Similarly rain and meltwater from storm sewage system will be collected and used. "Green roofs" will gain ground – planting of vegetation on buildings' roofs [12].

Irrigated farming as a major water consumer will change in a big way. Open channels supplying and distributing water will disappear in the world. Irrigation water will be transported (on the model of the majority of countries of Middle East) by closed pressure and free-flow conduits allowing avoidance of losses for evaporation and infiltration. Irrigated fields will become automated controlled, depending on climatic parameters, space. For soils with well-developed wicking properties in relatively plain valleys and individual plateaus, controlled subirrigation will be widely used. This is the system of moistening where all the water, save for precipitations, comes to a plant from groundwater. Groundwater level, depending on development stage of a plant and depth of its root zone, will be regulated by a system of underground pipelines spaced 1.5–3.0 m that will function both as deep drainage as well as water disposal during cessation of watering. Such pilot systems with automatic regulation of water conditions organized in Quebec (Canada) by McGill University, has been functioning for many years now [13-14].

Improved water-use systems will demand also improvement of drainage systems including collectors that will be closed. Dense observation network with sensors reflecting groundwater depth readable from the space, and also inspection manholes on collectors and drain lines with the same sensors will be under constant control of automated hydrogeological-reclamative parties. This will allow evaluation of drainage function, extent of salinity hazard, trace violations of forecasted water-salt balance and development of recommendations for using mineralized water and preventive maintenance of the drainage network for water-users [15].

Keeping of today's trends in water resources use and management is disastrous and inadmissible. It is a path of conflicts, crisis, hunger and thirst.

Recommendations and scenarios for prevention and mitigation of adverse effects of groundwater status change at regional and national levels in Kazakhstan.

Climate change should be considered as one of the main reasons for change in water basins environment, as well as one of many factors exerting pressure upon water resources. Therefore, scenarios of adaptation measures for specific basins, it is necessary to take into account not only climate changes, but also changes in demographic situation, economic growth dynamics, nutritional preferences etc. These scenarios must be developed with the maximum possible cooperation with neighbor countries, and what is especially important – with the use of models and data agreed with them [16-17].

– One of effective approaches to fulfilling the task of water resources management adaptation to climate change is the development of a plan (national or transboundary) of adaptation measures in the scales of a specific water basin (river, lake or groundwater), which subsequently could be integrated into (existing) plan of respective basin management.

– To develop strategy and scenarios, and also to identify vulnerabilities and adverse effects of climate change, it is necessary to have full information and data about the whole basin. Therefore, it is necessary to ensure collection and sharing of required information, data and models related to the basin as a whole, as well as to all water cycle components. To be able to flexibly manage the process to adaptation to climate change, required is a system of situation monitoring and regular correction of estimates, scenarios of climate change and forecasts of water balance status.

Potential of adaptation to changes and water safety. Strengthening of water safety often requires combining of technical, economic, production, legal and institutional measures. Water safety concept may help identify which measures are priority. Selection of measures depends on conditions and goals. Each specific situation has its problems and context that affect what can and must be done [18].

Committee for water resources of re-created in 2019 Ministry of Ecology, Geology and Natural Resources (EG&NE RK**)** is the national body responsible for the use and protection of water resources. It issues permits and consents for the use of surface water and underground water resources. It is also responsible for water supply system management. With the help of eight basin organizations responsible for the use of water resources in river basins and having advisory powers, its activity covers water resources management at the level of river basins. Committee for Geology and Subsoil Use of environmental protection issues permits and monitors status of groundwater. The National hydrometeorological institute, Kazgidromet monitors water quality and quantity. Territorial administrations of environmental protection supervise at oblast level, perform environment impact assessment and ensure monitoring of wastewater discharges. Through the Committee for Geology and Subsoil Use, the Ministry of EG&NE RK is responsible for groundwater status monitoring, including water quality. The Ministry of Health monitors situation with access to drinking water and its quality. Ministry of Emergencies carries out relevant activities in case of floods, droughts and ensures protection of water bodies from pollution resulting from emergencies. It also deals with the issues of safeguarding and security of waterworks.

Groundwater. Groundwater is the largest source of fresh water for the humanity. Isotopic methods are based on the use of stable and radioactive isotopes, naturally present in groundwater to identify origin of such water and rate of its replenishment.

Groundwater makes about 30 percent of water stock of fresh water. another 69 percent are concentrated in polar ice, and only one percent of fresh water is rivers and lakes. Groundwater often occurs in deep aquifers, permeable rock and sediments and is extracted via wells equipped with pumps. Aquifers in many cases are renewable sources that are slowly recharged by infiltration of precipitations within hundreds or even many thousands years.

Growth of the plant population along with farming intensification and increasing commercial consumption results in constant increase in demand for groundwater. In many regions water management bodies have to face excessive use of available aquifers, which often results in the necessity to use water from deep ancient beds to ensure reliable fresh water supply. Besides, there are hazards related to groundwater penetration of pollutants and toxins used for instance in agriculture, industry or activities of municipal services.

Scientific assessment of aquifers origin and rate of replenishment has a decisive importance, so that they could carry out their function of a reliable long-term source of water supply. Stable and radioactive isotopes naturally present in groundwater can be used for obtaining detailed information about

groundwater origin and replenishment rate. Water isotopes (hydrogen, oxygen) and radioisotopes (tritium), dissolved carbon (carbon-14) and inert gases (helium-3, helium-4 and krypton-81) are used to assess groundwater age.

Struggle with groundwater pollution is not an easy task since pollution of aquifers is quite difficult to eliminate. Stable and radioisotopic indicators (nitrogen-15, carbon-13 and tritium) are used for recording pollution sources and quantitative estimation of pollutants transformation and biodegradation in aquifer systems.

How can climate change affect status of global water stock in hundred years? To answer such questions, scientists resort to help of scientific models. One of them is water balance isotopic model developed by IAEA, by virtue of which specialists may quite precisely and reliably forecast the impact of climate change upon water resources in the far future. Information collected by them can be useful for decision-making authorities while developing strategies of sustainable water-use for future generations.

Such models are based on available data and are used for studying and apprehension of hypotheses, objects and processes, direct observations of which can be difficult. This relates also to preliminary calculations such as forecast of weather conditions for the next week or evaluation of unemployment rates within next five years. Although this model is in substance a more general and simplified picture of real world, each of its components is thoroughly calibrated to ensure faithful representation of processes going on in the reality.

Water balance models describe hydrological cycle from the view of precipitations falling processes, cumulative evaporation, river flow and change in volumes of water stock. As opposed to many traditional models of water balance, calibration and verification of IAEA model are performed based on data about isotopes, as isotopes are characterized with well-defined features and constancy in behavior. Resting upon thoroughly calibrated and verified water balance model, scientists may obtain a precise assessment of the processes that will be going on in the future, for instance, impact of climate change upon water resources in one hundred and more years. [19-20].

Study of climate in Kazakhstan. Starting from early 60-s', Kazakhstan experiences constant increase of temperature. Seasons become warmer on average. Temperature constantly rises, and increase rate is about 0.028 degree a year, or 0.28 degrees every 10 years. The system of calculation and evaluation of damage needs reforming. "It is necessary to take into account not only losses that have happened here and now, but also consider future economic losses from damage to health, infrastructure destruction or impairment" - experts say.

According to data of studies of RK Ministry of Energy and UNDP, maximum number of extremes in the nature of Kazakhstan occurred in 1999 - 268 cases with frequent repetition of heavy precipitations, snowstorms with windstorms and hail. Minimum number is 72 in 1995. Experts note that climate is still changing and will change in the future, and every year manifestations will be more noticeable. The study says that Kazakhstan to significant extent is exposed to natural disasters due to climatic and weather conditions: country occupies vast territory with different climatic zones – from very hot and dry desert belts in the south to very cold in winter steppe and forest belts in the north. "Climate will be drier and harder. Due to high air temperature, evaporation will grow as well as water consumption.

In XXI century, in Kazakhstan further significant climate warming in all scenarios under consideration should be expected. The forecasted change of average annual air temperature by 2030 will be within 1.5-1.7 degrees, and by 2085 temperature rise may make 2.7-4.7 degrees", - the experts say. East of Kazakhstan and Almaty oblast will suffer from changes in nature. Eastern and south-eastern territories of Kazakhstan may suffer to greater extent due to changes in nature. In mountainous area, all types of natural disasters are possible: landslides, mud flows, avalanches, floods, hurricane winds, hails, storm precipitations, frosts and droughts. Experts believe that Almaty oblast is under the highest exposure of extremes. Almost every second case happens in this region: heavy rains, wind, snow and snowstorm. Here, in the period of 2003-2015, as compared to previous period of 1990-2002, average annual number of cases with heavy rains increased by 3.9 times, with heavy snow – by 3.3 times, with strong wind – by 1.6 times. "Increase of number of mudflow events almost by two times, strengthening of output of extreme weather events – damage to environment, infrastructure and health of population, and this represents pressure not only to the state providing services of transportation, healthcare, prevention of emergencies, but to business operating in climate-oriented industries – tourism, agriculture, water resources. Companies operating in these areas will also experience and spend due to climatic events, and

this also needs evaluation and expertise", a specialist noted. Climate changes impacted and will impact all the population of the country, for instance, agricultural branch will be harmed. According to experts, intense atmospheric and soil draught is possible, which will destructively impact productivity of crops. Watering zones for crop farming will be shifted to zones where will be more ample precipitations and those zones will be losing their area.

Conclusion. This paper combines contemporary views about water safety and suggests methods of actualization of the concept in practice. It rests upon scientific literature and experience of partners along the chain of knowledge of the Global Water Partnership (GWP) about concept application in practice. The paper considers three components. The first – explains the concept of water safety and describes various frameworks where the concept is used. Comparison was made of approaches to water safety between development approach and the approach based on risk assessment. Second part describes relations between the concept of water safety and Water Resources Integrated Management (WRIM) and states that they are interconnected and that water safety should be considered as a WRIM goal. Third part suggests frameworks for quantitative estimation of water safety giving notes and recommendations, how to apply them at the national level, level of a riverbasin or city, and in a project scale. There is no "one-size-fits-all" solution. Decisions of water safety increase must be adapted to local conditions of each country, river basin, city, project and other management areas.

М. А. Мухамеджанов[1], Джей Сагин[2], Т. А. Рахимов[1], Я. О. Арыстанбаев[1]

[1]Satbayev University, Ахмедсафин атындағы
гидрогеология және геоэкология институты, Алматы, Қазақстан;
[2]Университет Саскачевана, Саскатун, Канада

2030 ЖЫЛҒА ДЕЙІН ӨҢІРЛІК, ҰЛТТЫҚ ЖӘНЕ ТРАНСШЕКАРАЛЫҚ ДЕҢГЕЙЛЕРДЕ КЛИМАТТЫҚ ЖӘНЕ АНТРОПОГЕНДІК ӨЗГЕРІСТЕР ЖАҒДАЙЫНДА ҚАЗАҚСТАН ХАЛҚЫ МЕН ЭКОНОМИКАСЫН ТҰРАҚТЫ СУМЕН ҚАМТАМАСЫЗ ЕТУ СЦЕНАРИЙЛЕРІН ӘЗІРЛЕУ

Аннотация. Әдістің мәні негізгі факторлардың болуы үшін сыртқы ортаны талдау және баламалы даму сценарийлерін құру үшін біріктірумен байланысты. Сценариялық көзқараста қалыптасқан баламалар қоршаған ортаны дамытудың мүмкін бағыттарының жиынтығын анықтауға және сол арқылы стратегиялық шешімдер қабылдауға негіз жасауға мүмкіндік береді. Бұл мақалада әртүрлі тәсілдер мен сценарийлерді қоса, сценарийді жоспарлаудың теориялық және әдіснамалық негіздері қарастырылады. Бұл әдісті Қазақстанда және шетелде қолдану тәжірибесі зерттелді.

Мақалада сумен жабдықтау жағдайына әсер ететін табиғи факторлар анықталған. Гидрогеологиялық жұмыстарды жетілдірудің балама стратегияларын одан әрі дамыту үшін сыртқы ортаны дамыту сценарийлерін құрудың орындылығы дәлелденді. Ұсынылған қағидалардың 2030 жылға дейінгі құрылыс алгоритміне және трансшекаралық деңгейге сүйене отырып, аймақтық, ұлттық және трансшекаралық деңгейлердегі климаттық және антропогендік өзгерістер жағдайында тұрақты сумен жабдықтау жоспарларын әзірлеу сценарийлері жасалды.

Сценарийлер шеңберінде кіретін жалпы экономикалық алғышарттар, аумақтарды дамытудың экономикалық факторлары және мемлекеттік реттеу анықталды. Әлеуметтік-экономикалық даму, сумен қамтамасыз етудің гидрогеологиялық жағдайларының жай-күйі қаралды. Ғылыми зерттеудің әдістемелік негізіне сценарийлік жоспарлау, стратегиялық және салыстырмалы талдау құралдарын қарастырумен стратегиялық басқарудың теориялық аспектілері алынған.

Стратегия мен сценарийлерді әзірлеу үшін, сондай-ақ климаттың өзгеруінің осалдықтары мен теріс салдарларын анықтау үшін барлық бассейн туралы толық ақпарат пен деректерге ие болу қажет. Сондықтан жалпы бассейнге қатысты қажетті ақпаратты, деректер мен үлгілерді, сондай-ақ су циклының барлық компоненттерін жинауды және бірлесіп пайдалануды қамтамасыз ету қажет. Климаттың өзгеруіне бейімделу процесін икемді басқару мүмкіндігі болу үшін, жағдайды мониторингілеу және бағалауды, климаттың өзгеру сценарийлерін және су теңгерімі жай-күйінің болжамдарын тұрақты нақтылау жүйесі қажет. Климаттың өзгеруін су бассейндері ортасының өзгеруін тудыратын басты себептердің бірі ретінде және су ресурстарына қысым көрсететін көптеген факторлардың бірі ретінде қарастырған жөн. Сондықтан нақты бассейндер үшін

бейімделу шараларының сценарийлерінде климаттың өзгеруін ғана емес, сондай-ақ демографиялық жағдайдың өзгеруін, экономикалық өсу серпінін, тамақтанудағы артықшылық және т.б. ескеру қажет.

Ауыз су сапасындағы жер асты суларының барланған қорларын ұтымды пайдалану жөнінде практикалық ұсынымдар әзірлеудің аса маңызды мәні бар. Бұл жағдайды аридті климат және су ресурстарының тапшылығы жағдайында ерекше ескеру қажет.

Бұл жұмыс су қауіпсіздігі туралы қазіргі заманғы түсініктерді біріктіреді және тұжырымдаманы іс жүзінде жүзеге асыру тәсілдерін ұсынады. Ол ғылыми әдебиеттерге және Жаһандық Су Серіктестік (GWP) білім тізбегі бойынша әріптестердің тұжырымдаманы тәжірибеде қолдану туралы тәжірибесіне сүйенеді. Жұмыста үш құрамдас бөлік қарастырылады. Біріншісі – су қауіпсіздігі тұжырымдамасын түсіндіреді және тұжырымдама қолданылатын түрлі шеңберлерді сипаттайды. Тәуекелдерді бағалау негізінде даму тәсілі мен тәсіл арасындағы су қауіпсіздігіне қатысты көзқарастарды салыстыру жасалды. Екінші бөлім су қауіпсіздігі тұжырымдамасы мен су ресурстарын интеграцияланған басқару (СРИБ) арасындағы қатынастарды сипаттайды және олардың өзара байланысты екенін және су қауіпсіздігін СРИБ мақсаты ретінде қарастыру керектігін бекітеді. Үшінші бөлім су қауіпсіздігін сандық бағалау үшін шектерді ұсынады, оларды ұлттық деңгейде, өзендік бассейн немесе қала деңгейінде және жоба ауқымында қалай қолдануға болады деген мысалдар мен ұсыныстарды келтіріледі. «Бір өлшемге сәйкес келетін» шешім жоқ. Су қауіпсіздігін арттыру жөніндегі шешімдер әрбір елдің, өзен бассейнінің, қаланың, жобаның және басқарудың басқа да салаларының жергілікті жағдайларына бейімделуі тиіс.

Түйін сөздер: сценарий әдісі, қоршаған орта факторлары, стратегия, балама сценарий.

М. А. Мухамеджанов[1], Джей Сагин[2], Т. А. Рахимов[1], Я. О. Арыстамбаев[1]

[1]Satbayev University, Институт гидрогеологии и геоэкологии
им. Ахмедсафина, Алматы, Казахстан;
[2]Университет Саскачевана, Саскатун, Канада

РАЗРАБОТКА СЦЕНАРИЕВ УСТОЙЧИВОГО ВОДООБЕСПЕЧЕНИЯ НАСЕЛЕНИЯ И ЭКОНОМИКИ КАЗАХСТАНА В УСЛОВИЯХ КЛИМАТИЧЕСКИХ И АНТРОПОГЕННЫХ ИЗМЕНЕНИЙ НА РЕГИОНАЛЬНОМ, НАЦИОНАЛЬНОМ И ТРАНСГРАНИЧНОМ УРОВНЯХ ДО 2030 ГОДА

Аннотация. Суть метода заключается в анализе внешней среды на наличие ключевых факторов и комбинировании их для создания альтернативных сценариев развития. Сформированные в сценарном подходе альтернативы позволяют выявить совокупность возможных направлений развития окружающей среды и тем самым создают основу для принятия стратегических решений. В данной статье рассмотрены теоретические и методические основы сценарного планирования, в том числе различные подходы и методы формирования сценариев. Изучен опыт применения данного метода в Казахстане и за рубежом.

В статье выявлены природные факторы, оказывающие влияние на условия водоснабжения. Обоснована целесообразность формирования сценариев развития внешней среды для дальнейшей разработки альтернативных стратегий для совершенствования гидрогеологических работ. На основе алгоритма построения и трансграничном уровнях до 2030 года предложенных принципов разработаны сценарии развития планов устойчивого водообеспечения в условиях климатических и антропогенных изменений на региональном, национальном и трансграничном уровнях.

В рамках сценариев рассмотрены входящие общеэкономические предпосылки, экономические факторы развития территорий и государственное регулирование, социально-экономическое развитие, состояние гидрогеологических условий водообеспеченности. В методическую основу научного исследования положены теоретические аспекты стратегического управления с рассмотрением инструментария сценарного планирования, стратегического и сравнительного анализов.

Для разработки стратегии и сценариев, а также для выявления уязвимостей и негативных последствий изменения климата необходимо располагать полной информацией и данными обо всем бассейне, поэтому необходимо обеспечить сбор и совместное использование необходимой информации, данных и моделей, касающихся бассейна в целом, а также всех компонентов водного цикла. чтобы иметь возможность гибко управлять процессом адаптации к изменению климата, необходима система мониторинга ситуации и регулярного уточнения оценок, сценариев изменения климата и прогнозов состояния водного баланса.

Изменение климата следует рассматривать как одну из главных причин, вызывающих изменение среды водных бассейнов и как один из многочисленных факторов, оказывающих давление на водные ресурсы. Поэтому в сценариях мер адаптации для конкретных бассейнов необходимо учитывать не только изменение климата, но также и изменения демографической ситуации, динамики экономического роста, предпочтений в питании и т.д. Эти сценарии должны разрабатываться при максимально возможном сотрудничестве с соседними странами, и что особенно важно – с использованием согласованных с ними данных и моделей.

Особо важное значение имеет разработка практических рекомендаций по рациональному использованию разведанных запасов подземных вод питьевого качества. Особенно важно учитывать данное положение в условиях аридного климата и дефицита водных ресурсов.

Данная работа объединяет современные представления о водной безопасности и предлагает способы реализации концепции на практике. Она опирается на научную литературу и опыт партнеров по цепочке знаний Глобального Водного Партнерства (GWP) о применении концепции на практике. В работе рассматриваются три составляющие. Первая − объясняет концепцию водной безопасности и описывает различные рамки, в которых используется концепция. Сделано сравнение подходов к водной безопасности между подходом развития и подходом на основе оценке рисков. Вторая часть описывает отношения между концепцией водной безопасности и Интегрированным управлением водными ресурсами (ИУВР) и утверждает, что они взаимоувязаны, и что водную безопасность следует рассматривать в качестве цели ИУВР. Третья часть предлагает рамки для количественной оценки водной безопасности, приводя примеры и рекомендации, как их применять на национальном уровне, уровне речного бассейна или города и в масштабе проекта. Не существует решения «один-размер-подходит-всем». Решения по повышению водной безопасности должны быть адаптированы к местным условиям каждой страны, речного бассейна, города, проекта и другим областям управления.

Ключевые слова: метод сценариев, факторы внешней среды, стратегия, альтернативный сценарий.

Information about authors:

Mukhamedzhanov M.A., Chief Researcher, Doctor of Geological and Mineralogical Sciences, Satbayev University, Ahmedsafin Institute of Hydrogeology and Environmental Geoscience, Almaty, Kazakhstan; muratmukhamtd09@rambler.ru; https://orcid.org/0000-0002-0822-9307

Sagin Jay, Assistant Professor, University of Saskatchewan, Saskatoon, Canada; jay.sagin@usask.ca; https://orcid.org/0000-0002-0386-888X

Rakhimov T.A., Head of the Laboratory of regional hydrogeology and geoecology, Satbayev University, Ahmedsafin Institute of Hydrogeology and Environmental Geoscience; t-rakhimov@mail.ru; https://orcid.org/0000-0002-0976-4643

Arystanbaev Y.O., Leading Engineer, Satbayev University, Ahmedsafin Institute of Hydrogeology and Environmental Geoscience Almaty, Kazakhstan; yarystan47@mail.ru; https://orcid.org/0000-0002-2363-5653

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