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Satbayev University

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ИЗВЕСТИЯ

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INCREASING WATER PRODUCTIVITY IN IRRIGATION WITH REGARD TO GEOLOGY AND HYDROGEOLOGICAL CONDITIONS

Abstract. The article focuses on increasing irrigation water productivity in irrigated agriculture in complex ground-soil conditions of the area, where groundwater of low salinity is expedient to use for domestic and drinking water supply.

The article includes study of potential capabilities to meet water demand of all water consumers in river basin in perennial section, as well as possibilities of irrigation water supply to suspended irrigated areas.

Examined issues of dispatching management of water distribution systems in the reclamation channels using a systematic approach. Integrated automated control systems are actively developed implemented to manage water distribution in irrigation canals. The analysis also revealed concerns preservation of natural complexes, the main indicator of ecosystem stability, which means equilibrium between inflow and evaporation, favorable conditions of the delta, floodplain forests, sustainable water supply to economy and population. The involves analysis of water yield indicators, namely water consumption regimes of economic sectors, for irrigated agriculture as the main consumer in particular.

Methodology for analysis of water resources use for irrigated agriculture is presented. Principles of water use efficiency under dry year conditions (Pw =90% occurrence) with regard for natural ecosystems complexes conservation and water losses from reservoirs are developed. First-priority measures on stimulation of water use efficiency increase, which consist of irrigation water payment tariffs and water use subsidies value (on example of Bartogai water reservoir influence zone on Shelek river), are proposed.

Key words: irrigation water productivity, ground-soil conditions, firm yield, stimulation, hydrogeological conditions, geological conditions.

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ГЕОЛОГИЯЛЫҚ ЖӘНЕ ГИДРОГЕОЛОГИЯЛЫҚ ЖАҒДАЙЛАРДЫ ЕСКЕРЕ ОТЫРЫП, СУАРУ КЕЗІНДЕ СУДЫҢ ӨНІМДІЛІГІН АРТТЫРУ

Аннотация. Бұл мақалада шаруашылықты ауыз сумен қамтамасыз ету үшін тұздылығы төмен жер асты суларын пайдалану арқылы, күрделі топырақ жағдайындағы суармалы егіншілікпен айналысатын аудандарда суаруға арналған судың өтімділігін барынша арттырудың мәселелері қарастырылған.

Сонымен қатар, өзен бассейніндегі барлық су тұтынушылардың суға қажеттілігін көпжылдық қимада қанағаттандыру әдістері бойынша әлеуетті мүмкіндіктері зерделенеді. Бұл бағыт бойынша тоқтатылған суармалы алқаптарды суармалы сумен қамтамасыз ету мүмкіндігін қарастырумен де толықтырылады.

Сондай-ақ, жүйелік тәсілді қолдана отырып, мелиорациялық каналдардағы су тарату жүйелерін диспетчерлік басқару мәселелері қарастырылды. Қазіргі таңда суару арналарында су таратуды басқару үшін енгізілген кешенді автоматтандырылған басқару жүйелері белсенді дамуда. Соған сәйкес, талдау нәтижесінде табиғи кешендерді сақтау мәселесі ескерілді, бұл ағын мен булану арасындағы тепе-теңдікті, жайылым жерлер мен ормандардың әл-ауқатын, экономика мен халықты тұрақты сумен қамтамасыз етуді ескереді. Бұл жұмыста су қайтарымы көрсеткіштерінің нәтижелері, атап айтқанда экономика салаларының, негізгі тұтынушы көзі ретінде суармалы егіншіліктің су тұтыну режимдері келтірілген.

Осыған байланысты біз суармалы егіншілік үшін су ресурстарын пайдаланудың жай-күйіне талдау жүргізу әдістемесін ұсындық. Экожүйенің табиғи кешендерін сақтауды және су қоймасынан су ысырабын ескере отырып, суы аз жыл жағдайларында суды пайдалануды қайтарымды (Pw = 90% қамтамасыз етілу) белгілеу қағидаттары әзірленді. Талдау негізінде суармалы су үшін төлемақы тарифтерін және су ресурстарын пайдалануға арналған субсидиялар шамасын тағайындаудан

(Шелек өзеніндегі Бартоғай су қоймасының әсер ету аймағы мысалында) тұратын суды пайдаланудан түсетін қайтарымды арттыруды ынталандыру жөніндегі бірінші кезектегі шаралар ұсынылды.

Түйін сөздер: суармалы судың өнімділігі, жер-топырақ жағдайлары, тұрақты өнімділік, ынталандыру, гидрогеологиялық жағдайлар, геологиялық жағдайлар.

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ПОВЫШЕНИЕ ПРОДУКТИВОСТИ ВОДНЫХ РЕСУРСОВ В ОРОШЕНИИ С УЧЕТОМ ГЕОЛОГО-ГИДРОГЕОЛОГИЧЕСКИХ УСЛОВИЙ

Аннотация. Статья посвящена комплексному исследованию повышение продуктивности поливной воды в орошаемом земледелии в сложных грунтово-почвенных условиях района, где подземные воды невысокой минерализации целесообразно использовать для хозяйственно-питьевого водоснабжения.

Изучены потенциальные возможности по удовлетворению потребности в воде всех водопотребителей в бассейне реки в многолетнем разрезе. Данное направление дополняется также рассмотрением возможности обеспечения поливной водой подвешенных орошаемых площадей.

А также рассмотрены вопросы диспетчерского управления системами водораспределения в мелиоративных каналах с применением системного подхода. Активно развиваются комплексные автоматизированные системы управления, внедряемые для управления водораспределением в оросительных каналах. В результате анализа учитывался вопрос сохранения природных комплексов, означающий равновесие между притоком и испарением, благополучие дельты, пойменных лесов, устойчивое водоснабжение экономики и населения. В данной работе приведены результаты показатели отдачи воды, а именно режимы водопотребления отраслей экономики, в частности орошаемого земледелия, как основного потребителя.

В этой связи нами представлена методика проведения анализа за состоянием использования водных ресурсов для орошаемого земледелия. Разработаны принципы установления отдачи от использования воды в условиях маловодного года (Pw = 90% обеспеченности) с учетом сохранения природных комплексов экосистемы и потерь воды из водохранилища. На основании анализа предложены первоочередные меры по стимулированию повышения отдачи от использования воды, заключающиеся в назначении тарифов платы за оросительную воду и величины субсидий на использование водных ресурсов (на примере зоны влияния Бартогайского водохранилища на реке Шелек).

Ключевые слова: продуктивность поливной воды, грунтово-почвенные условия, обеспеченность отдачи, стимулирование, гидрогеологических условий, геологических условий.

Introduction. Nowadays, Kazakhstan, along with many countries of the world, is experiencing a shortage of water resources due to the rapid pace of development, as well as the impending global climate change. Meanwhile, high biological and climatic land potential, as well as human resources in the country enable the favorable development of irrigated agriculture, can provide the population with food and become one of the world's leading experts with regard to agricultural production. Nevertheless, to date, the economy of Kazakhstan consumes water three times more per dollar of GDP than Russia or the United States. (Informational and analytical review for parliamentary hearings on the topic: «Water security of Kazakhstan: state, problems and recommendations», 2019) At the same time irrigation water productivity abroad is 2.5 - 6.0 kg/m^3, while in Kazakhstan - only 0.4 - 0.8 kg/m^3. Irrigation water consumption per 1 kg of yield, respectively: 165-600 m^3/t; 1200-2500 m^3/t. It should be noted that yields in Kazakhstan for all types of crops are 2-4 times lower than in other countries. One of the measures to improve water saving and increase yield from water use is to improve efficiency of economic regulation mechanisms in terms of reducing water intensity of agricultural production. In this connection we shall consider current situation with water consumption on irrigated massifs along the branch of the Big Almaty Canal named after D. Kunayev., which draws water from the Bartogai reservoir, since the fields explored for irrigation are currently exploited only for domestic and drinking water supply (in the volume of 3-5% of explored reserves). Almost since reserves were approved, underground water has hardly been used in the region for land irrigation (Makyzhanova A.T. et. al, 2018).

Materials and methods. A variety of relief, source rocks, and different climatic conditions have determined a large set of soil and plant types in the region. Genetically heterogeneous soil-forming rocks (glacial, alluvial, proluvial, dealluvial) play a paramount role in the formation of the soil cover of the region. The following types and subtypes of soils were formed in the

Bartogai reservoir influence zone: grey-brown desert, takyr and takyr-like; light and ordinary grey soils; brown desert-steppe; foothill dark chestnut and light chestnut; mountain chernozems podzolic and leached; mountain forest dark colors; mountain-meadow alpine and subalpine. Meadow, meadow-marsh, floodplain-meadow soils, solonchaks, solonetz, as well as non-soil formations (sands, glaciers, rocky bedrock exposures) are encountered throughout the area.

Natural and geological conditions of the region, marked by the presence of mountain ridges and intermountain depressions, a variety of river valleys contributed to the formation of large groundwater reserves in this area, most of which relate to aquifers of Quaternary, Neogene, Paleogene, Cretaceous deposits of intermountain depressions (Smolyar V.A., et. al, 2012).

Nevertheless, it is scientifically proved that irrigated agricultural production based on groundwater justifies itself only for the development of individual small areas, under the condition of application of water-saving, mobile, easy-to-use irrigation systems, irrigation methods and techniques that do not require large-discharge sources and significant pressures (Allen R.G., et. al, 2010). In this regard, in order to obtain sustainable yields in the Bartogai reservoir influence zone, use of surface water would be the most rational approach.

The volume of water withdrawal from the Big Almaty Canal in 2019 and 2020 on irrigated massifs was 786.4 and 811.0 million m^3, and irrigation water supply was 628.4 and 643.5 million m^3, respectively. The plan for water intake was fulfilled by 98.7%, and for water supply - by 99.6%. It should be noted that the matter here is about water yield from the reservoir (Pα), which includes factors of flow formation related both to flow yield (Pw) and to parameters of water management system and reservoir operation regime, together with provision of irrigation norms for agricultural crops (Pm).

The latter, in its turn, follows from irrigated agriculture water consumption regime, represents actual level of irrigation system water requirement provision and is taken at the level of 95% firm yield. Formation of water resources directly depends on climatic factors (ignoring accompanying factors), and water requirements of irrigation systems depend on hydrometeorological factors of irrigation area being random processes that change according to their regularities in a multi-year period.

Table 1 shows data on the gross harvest and yields of the main crops on irrigated lands for the Big Almaty Canal Branch.

Table 1. Gross harvest and yields of the main crops on irrigated lands for the branch of BAC named after D. Kunayev, Republican State Enterprise «Kazvodkhoz» in the Shelek river basin

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№	Crops	Sown, ths. ha	Harvested, ths. ha	Yield, centner/ha	Gross yield, ths. centner
1	Industrial crops	10,034	10,034	25,7	25,8
2	Corn for grain	18,810	18,810	66,6	125,3
3	Corn for silage	0,265	0,265	50,1	1,3
4	Grain crops	1,007	1,007	46,4	4,7
5	Gardens and vineyards	6,111	6,111	76,9	47,0
6	Gourd vegetables	2,528	2,528	311,4	78,7
7	Perennial grasses (for hay or green fodder)	12,541	12,541	135,4	169,8
8	Household plots	0,544	0,544	-	-
	TOTAL	51,296 +0,544			

As can be seen from the table, low crop yields are observed under practically fulfilled plan on water intake and water supply. It should be noted that this situation is observed in many irrigation systems of the country. Therefore, the issues of analysis and development of primary measures on increasing irrigation water yield and productivity for the purpose of balanced water distribution management in the irrigation systems are relevant.

Results and discussion. Determination of irrigation water use efficiency in irrigation systems and assignment of priority measures for its increase consists of three stages.

The first stage includes study of potential capabilities to meet water demand of all water consumers in river basin in perennial section, as well as possibilities of irrigation water supply to suspended irrigated areas.

There are no priority water consumers; the environmental or ecological flow left in the water source is about 10% of the annual flow, i.e., 93 million m^3 (Zauirbek A.K., et. al, 2016). Available water resources will be equal to 779 million m^3. In such conditions it would be possible to provide 779 -10^6/(8.83 -10^3)=88.2 thousand ha of irrigated lands with gross irrigation norm of 8826 m^3/ha on the base of the Canal.

However, in years with flow availability (Pw) above 90%, it is necessary to introduce restrictions in water supply to water consumers and, given the priority of growing crops in irrigated agriculture, switch to reduced yields in accordance with the rules of water use dispatch schedule (Schwab C., 2008). Examine issues of dispatching management of water distribution systems in the reclamation channels using a systematic approach. Integrated automated control systems are actively developed implemented to manage water distribution in irrigation canals (José Ruidival dos Santos Filho 2004).

The second stage concerns preservation of natural complexes, since according to (Zauirbek A.K., et. al, 2020). for Lake Balkhash, the main indicator of ecosystem stability is the minimum lake level of 341.0 m BES, which means equilibrium between inflow and evaporation, favorable conditions of the delta, floodplain forests, sustainable water supply to economy and population, etc.

In this regard, we propose the following directions of rational use and protection of natural complexes in Balkhash-Alakol basin:

a) maintenance of the minimum lake level of 341.0 m BES, which implies that the volume of water consumption in the basin should not exceed 3-4 km^3 per year. However, this boundary has been passed long ago, with the volume of water consumption on the territory of China today being about 5 km^3, and that of Kazakhstan - 3 km^3.

b) let us assume that the mark of 341.0 m is already impossible to hold. For example, nowadays, the limit of 5% of natural resources use is exceeded almost everywhere by all components of the ecosphere, especially by the level of water resources use. If there is no possibility to limit the level of use of water resources to the 5% threshold, then for any intermediate level of 5-95%, it is necessary to establish the state of the environment and the possibility of coordinating the level of technogenic load on the ecosphere with the «possible endurance of the natural environment» at a new level. In the natural-anthropogenic sphere, it makes sense to consider a compromise variant of society and nature coexistence at the optimal socio-ecological and economic level (Poryadin V.I., 2017).

Hence, when using any kind of natural resource, one should follow the rule of optimum, under which the optimal value of the level of use of natural resources depends on the existing system of views and points of view, the development and depth of scientific research, as well as the level of development of the society itself. Our research shows that under modern level of technology of water resources use in branches of economy, optimal level of water resources use is $\alpha = 0.18$. Naturally, as water withdrawal from a water source increases, incomes of economic sectors will increase, but negative consequences from depletion and pollution of a water source will increase at the same time (The Brisbane Declaration 2007). If Kazakhstan moves to higher technologies of water resources use in the sectors of the economy, then from the socio-ecological and economic point of view the optimal level of water use in the basin can increase, the optimal level of water resources use in the studied region will be equal to 0.55 (55%). Therefore, the total volume of water consumption in the basin will roughly equal to 16 km^3 of water per year.

However, in this case, the water level in Lake Balkhash, will be much lower than 341.0 m, which can lead to unpredictable consequences (Severs E. 2002).

Therefore, let us assume that in the Balkhash-Alakol water basin, the limit level of water use should not exceed 35% of water use, which is 10 km^3 of water per year. Hence, it follows that China and Kazakhstan should not take more than 10.0 km^3 of water per year from the Ile River in perspective, i.e., each of the two countries will use 5 km^3.

c) replenishing the flow of the Ile River from outside, from the Yenisei River basin. This option was proposed earlier, although, in our opinion, the implementation of this measure at present is not ecologically and economically feasible.

The third stage involves analysis of water yield indicators, namely water consumption regimes of economic sectors, for irrigated agriculture as the main consumer in particular.

Analysis shows that in 2020, water consumption of irrigated massifs in Canal zone did not change along with change of air temperature regime during vegetation period. This is attributed to the fact that different crops and their irrigation regimes are considered. For example, for winter and spring cereals the vegetation period ends already in June - beginning of July.

Then we set the actual values of irrigation rates, Table 2.

Table 2. Actual irrigation standards of conditional structural hectare (established based on data of the BAC branch for 2020)

№	Indicators	BAC branch divisions by district						Total
		Yenbekshikazakh district				Talgar	Kurty	
		Bartogai	Shelek	Tausutur	Yenbekshi kazakh			
1	Actual area, ha	3643	13484	10647	14063	3199	2137	47178
	Actual area, %	7,7	28,6	22,6	29,8	6,8	4,5	100,0
2	Water intake, mln. m^3	109,49	323,42	192,82	128,12	23,16	36,93	810,98
3	Water supply, mln. m^3	88,39	258,23	156,18	103,78	18,76	18,11	643,53
4	Water supply efficiency	0,83	0,80	0,81	0,81	0,81	0,49	0,78
5	Gross irrigation norm, thousand m^3/ha	29,2	24,0	18,1	9,11	7,2	17,3	17,2
6	Irrigation water productivity (yield), kg/m^3	0,044	0,054	0,071	0,141	0,179	0,074	0,092
7	Irrigation water consumption, m^3/kg	22,6	18,6	14,0	7,1	5,6	13,4	10,9

The current state of the water management system in the Bartogai reservoir area is presented in detail in ref. (The report of the branch «D. Kunaev Big

Almaty Canal» 2020). With the actual water intake from the source equal to 810.984 million m^3, the gross irrigation norm is 14.045 thousand m^3/ha, while according to, the actual gross irrigation norm is more than 29.2 thousand m^3/ha, due to hidden masses of irrigated land, Figure 1.

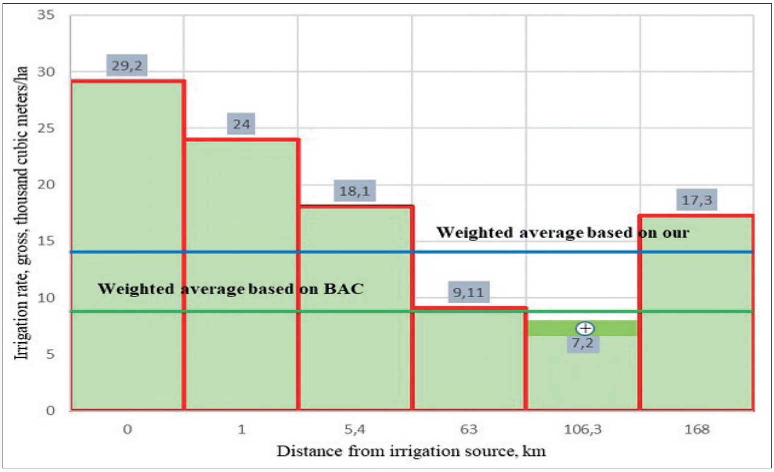

Figure 1. Gross irrigation norm (weighted average by divisions of the Big Almaty Canal Branch)

Then we set the irrigation norm of structural hectare allowed by BAC branches, which is defined in aggregate according to the following equation:

$$(Mw.av.gr)_{p.kave} = [\Sigma\ (Mw.av.gr)_{p.ki} \cdot \omega_{ki} \cdot \alpha_{ki}\ ]/\Sigma\omega_{ki}. \qquad (1)$$

where $(Mw.av.gr)_{p.kave}$ - weighted average permitted value of irrigation norm of conditional structural hectare by kth branch division; $(Mw.av.gr)_{p.ki}$ - weighted average permitted value of irrigation norm of the ith crop of the k-th branch. Let us consider the situation in Yenbekshikazakh and Shelek districts located downstream of the Big Almaty Canal: - agroclimatic humidity zone - southern desert, humidity factor Ku=0.10-0.15;

- name of agricultural crop - spring cereals; net irrigation norm - 3400 m^3/ha; water losses during irrigation - 1831 m^3/ha; water losses during transportation - 6511 m^3/ha; water consumption - 11742 m^3/ha.

Only water consumption values are given for other crops.

Average weighted permitted value of irrigation norms of conditional structural hectare by kth Bartogai branch of the Canal will be 20508 m^3/ha, which is 1.42 times higher than the calculated value.

Then we establish water yield from water use. Specific gross output from a unit of irrigated area (yield) on average for the branch is calculated as:

$$(GOsp)_{ave} = \Sigma (y_i \cdot \alpha_i \cdot \omega_i) / \Sigma \omega_i = \Sigma(GO_i \cdot \alpha_i \cdot \omega_i) / \Sigma \omega_i = 1290 \text{ kg/ha} \quad (2)$$

where $(GOsp)_{ave}$ - specific gross output from a unit of irrigated area, kg/ha;
y_i - yield of the main i[th] crop on irrigated lands;
ΣGO_i – total value of gross output of the main i[th] crops on irrigated lands, thousand metric centners.
α_i - share of the main i[th] crops on irrigated lands;
ω_i - irrigated areas allocated to the main i[th] crops.
Irrigation water productivity is determined by the following formula:

$$(PRsp)_{ave} = (GOsp)_{ave} / Mw.av.gr.ave = 1290 / 14045 = 0{,}092 \text{ kg/m}^3 \quad (3)$$

Irrigation water productivity is determined by the following formula:

$$(PRsp)_k = (PRsp)_{ave} / Mw.av.gr.k = 1290/29\,200 = 0{,}044 \text{ kg/m}^3 \quad (4)$$

Then irrigation water productivity will be: $(GOsp)_{bart} = 1290/29\,200 = 0{,}044$ kg/m^3

Irrigation water consumption per 1 kg of crop in the Canal branch total is calculated as

$$(IWCsp)_{ave} = Mw.av.gr.ave / (PRsp)_{ave} = 14045 / 1290 = 10{,}9 \text{ m}^3\text{/kg} \quad (5)$$

Irrigation water consumption per 1 kg of yield:

$$(IWCsp)_k = Mw.av.gr.k/(PRsp)_k = 29200/1290 = 22{,}6 \text{ m}^3\text{/kg} \quad (6)$$

Water yield is calculated by the following formula:

$$(AGOsp)_{ave} = (CGO = GO \cdot p)/\omega,$$
$$(CGOsp)_{ave} = (CGO = GO \cdot ц)/\omega, \quad (7)$$

where $(AGOsp)_{ave}$ - water yield, on average;
CGO – cost of gross output, total;
GO - gross output, total;
p – purchase price of cereals (accepted 200 USD/t or 20 USD/metric centner);
ω - irrigated area;
Substituting known values into formula (7), we obtain the following $(AGOsp)_{ave}$ = 258,9 USD/ha. Calculation results are shown in figure 2.

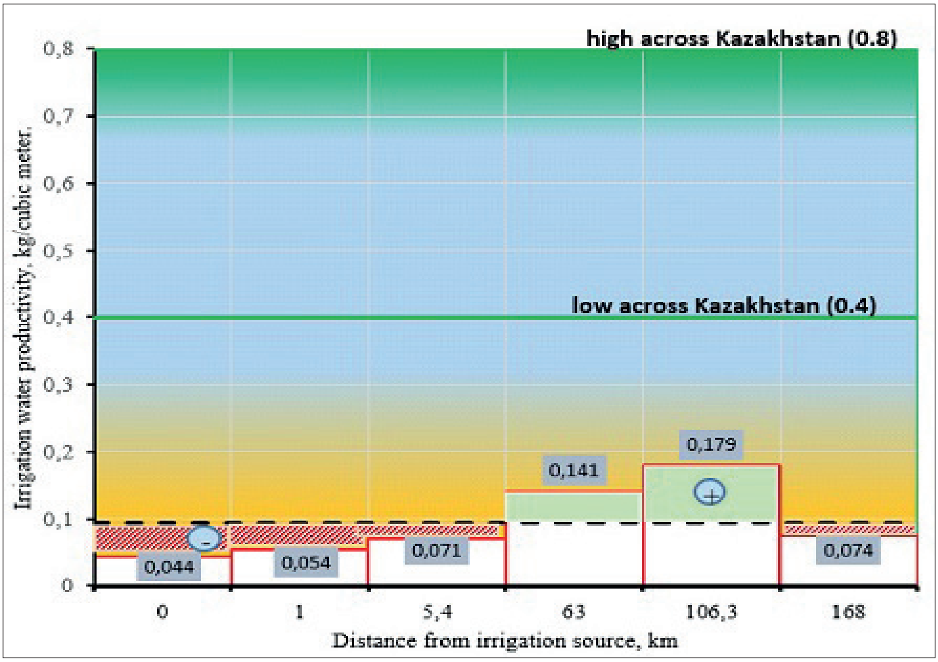

Figure 2. Water productivity (weighted average by divisions of the Big Almaty Canal) for 2020 and proposals on assignment of subsidies for water resources use in the Bartogai reservoir zone (plus - increase in the value of subsidies, minus - decrease in the value of subsidies).

As can be seen from the figure, irrigation water productivity in the Canal impact zone is very low (the maximum value is 0.179), which is more than 2 times less than the lower limit (0.4) in the Republic of Kazakhstan, and 4 times more than the higher limit.

In order to increase water yield in irrigation systems, it is necessary to introduce economic management levers. One of the first-priority measures for increasing water use yields is payment for water according to (Decree of the President of the Republic of Kazakhstan on the State program for the development of the agro-industrial complex of the Republic of Kazakhstan for 2017-2021), under which it is supposed to reduce irrigation water consumption per 1 ha of irrigated area from 9180 m^3 by 20% to 7348 m^3 by the level of 2015.

Further improvement of the economic mechanism of paid water use in order to harmonize the interests of the state, water management organizations and users of irrigated lands is becoming an urgent task of the economic policy of the state at the present stage of development of the national economy. (Sandra Postel, 2000).

The solution of this task involves an in-depth study of the state of operation of irrigation systems and irrigated lands of the country, the main directions of rational use of water resources on irrigated lands and the development of a market mechanism for water management (Dellavell M., et. al, 1986).

In addition, under the conditions of the Big Almaty Canal Zone, the following incentives for water users are proposed:

a) farms that exceed water consumption norms pay 5- fold for irrigation water volume exceeding the established norm. Taking into account that tariff increase is a social issue, water users should be interested in using water-saving technologies by introducing preferential tariffs for provided set of equipment and devices for water-saving;

b) farms that consume water within the norm of water consumption pay within the assigned tariff;

c) farms that consume water below water consumption norm (which achieved water saving) pay.

- in case of water saving up to 30-40% - half the assigned tariff;
- in case of water saving up to 50-60% - four times lower than the assigned tariff.

It should be noted that nowadays in Kazakhstan, the subsidies allocated to agricultural workers do not stimulate water consumers, and farms are not interested in saving water and land resources. In this connection, in our opinion, it is necessary to change the policy of state support to farms by stimulating and allocating subsidies for improving the productivity of water and land resources use, improving the ecological and reclamation state of irrigated lands, providing all possible support to those who implement water-saving technologies and irrigation methods. For this purpose, we propose to provide the following state financial support in the form of subsidies:

a) farms with water yield from its use lower than the average for the watershed management do not receive any subsidies;

b) farms with water yield from its use within the average for the watershed management receive subsidies within the average for the watershed management;

c) farms with water yield from its use higher than the average for the watershed management (who implemented progressive technologies of water use)

- up to 2 times - receive 120% of the subsidy amount;
- up to 4 times - receive 150% of the subsidy;
- farms that have brought it up to the level of advanced states receive double subsidy.

Conclusions. 1. Geological and soil conditions of Bartogai reservoir influence zone, covering mountain, piedmont and steppe natural-climatic zones have been studied. We have established that the region is located in complex soil-sandy conditions; foothill dark-chestnut and light-chestnut, meadow and mountain-meadow types of soils of different mechanical composition prevail.

2. We have established that the deposits explored for irrigation in the region are currently exploited only for domestic-drinking water supply (in the volume of 3-5% of the explored reserves). Almost since reserves were approved, underground water has hardly been used in the region for land irrigation in view of its costliness.

2. We have developed principles of surface water use efficiency and defined the first-priority measures for its increase, which consist of the following stages:

2.1 Estimated flow and irrigation capacity in years of low water availability (Pw = 90% occurrence) are established, taking into account the value of nature protection release and water losses from the reservoir;

2.2 The options of preservation of natural complexes, the ecological condition of which depends on the level of water resources use in the river basin, are considered;

2.3 Water yield indicators are determined taking into account water consumption regimes of agricultural crops with subsequent comparison with actual values of irrigation norms. It is established that in Bartogai water reservoir influence zone, irrigation gross norm on initial plots, using water of the Canal, decreases from 29,2 to 7,2 thousand m^3/ha, then again increases to 17,2, exceeding permitted (allowable) value in Bartogai division by 1,42 times. At the same time, irrigation water productivity on average on the Canal branch and in its zone of activity at the initial sites increases from 0.044 to 0.179 kg/m^3; then decreases to 0.09.

3. Presently in Kazakhstan, the subsidies allocated to the workers of the agricultural sector do not stimulate water consumers to save water. In this connection, we have proposed and substantiated incentives for water saving, with assignment of differentiated norms of water charges and subsidy amounts.

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