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Satbayev University

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

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ECOLOGICAL PROFILE OF DRAINAGE IN THE SHU RIVER BASIN UNDER ANTHROPOGENIC ACTIVITY

Abstract. Based on the study, many years of information and analytical materials «Kyrgyzhydromet» and «Kazhydromet», as well as the Department of State Statistics of the Kyrgyz Republic and the Republic of Kazakhstan, characterizing the formation of water resources and their use in the economic sectors of the catchment area of the Shu River basin, were considered as a model of the "activity-natural system", which performs runoff, environment-forming, ecological and social functions and is the spatial basis of nature management for a comprehensive assessment of the state of the territory and water bodies. As a basis for assessing the main functions of the catchment area of the Shu River basin, a geosystem approach was used, which determines the scientific and practical feasibility of geomorphological schematization, within the framework of which it becomes possible to construct their ecological profile on a spatio-temporal scale, which makes it possible to establish trends in the development of cognitive and transformative activities that determine the direction and intensity of anthropogenic activity. in the region. The main natural function of the river basin of the formation of a hydrogeochemical flow, which has one object for its discharge, determines the qualitative state of the ecological profile of the catchment area of the Shu River basin, that is, depending on the zonation from the mountainous class of landscapes to the lowland class of landscapes (superaquial and subaquial facies), natural hydrological facies are gradually disrupted. rhythms, affects the hydrogeological and soil-reclamation processes and environmental conditions, especially in the lower reaches of river basins, which are zones of storage of return (collector-drainage and waste) waters of industrial and agricultural facilities.

Key words: river, catchment, basin, runoff, system, model, function, activity, transformation, cognition, ecology, profile, schematization, analysis, assessment.

Introduction. The historical development of mankind in the 15th-18th centuries, if it directly depended on the power of Mother Nature, then, starting from the 19th century, the well-being of the natural system largely depends on human activity in the system of nature management and environmental management. Over the course of two millennia, history has experienced many situations, on the successful completion of which the ecological well-being and development of mankind on planet Earth depended. However, despite the fact that society is still increasing the pace of satisfying consumer needs at the expense of the natural environment, and nature itself serves as the resource and material-spatial basis of society, until now society does not remember a natural phenomenon, which is a global threshold process, beyond which progress may turn out to be not only difficult, but generally impossible.

But society, in certain geographic regions of the planet, today faced many trials, that at the beginning of the new millennium, humanity came aggravated by the problems of survival, since the driving force in the XXI century was human needs, which were formed under the influence of the consumer spectrum of values and the apparent availability of natural resources in various areas of production.

Thus, one of the primary goals of ecology is the formation of ecological consciousness and the implementation of human ecological thinking in solving scientific and practical problems in the field of nature management, and the related arrangement of the catchment area of river basins.

The purpose of research - on the basis of the analysis of the environment-forming and economic functions of the river basins and which are the spatial basis for the use of natural resources, to construct the ecological profile of the catchment area of the Shu river basin in conditions of anthropogenic activity.

Object of study - the Shu river, which originates in the Teskey-Ala-Too glaciers and the Kyrgyz ridge. The Shu River flows through the territories of Kyrgyzstan and Kazakhstan. The length of the river is 1186 km, including 800 km within Kazakhstan. Drainage area - 67 500 km². The main tributaries: on the right – Chong-Kemin, Yrgayty, Kakpatas; on the left – Alamedin, Aksu, Kuragaty. In the lower reaches, the river flows through Kazakhstani territory, forming the northern border of the Moyynkum desert, dries up in the sands, only during floods, flowing into the closed-drainage salt lake Akzhaikyn among the vast salt marshes of the Ashchykol depression.

The geomorphological profile of the catchment area of the Shu river basin, built on the basis of the catenary approach, depending on the altitudinal zonality, is divided into zones: a mountainous class of landscapes (eluvial facies), a foothill subclass of landscapes (transeluvial facies), a foothill lowland subclass of landscapes (transaccumulative class of landscapes) and plains (superaquial and subaquial facies) (table 1) [1].

Table 1 – Geomorphological schematization of landscape catenas of the catchment area of the Shu river basin

Natural and climatic zones			Weather station	The absolute height of the earth's surface, m	Administrative regions
landscape class	facies	moisture zones			
Mountainous	Eluvial	Wet mountain	Teo-Ashuu	3090,0	Kemen, Chui-Tokmasky (KR)
Foothill	Transeluvial	Arid mountain	Baytik	1590,0	Chui-Tokmasky (KR), Issyk-Ata (KR)
Foothill plain	Transaccumulative	Dry foothill	Kordai Bishkek	1145,0 756,0	Chui-Tokmasky (KR), Alamudunsky, Sokuluk, Moskovsky, Zhayilsky, Panfilovsky (KR) Korday (RK)
Plain	Superaquial	Very dry	Tole bi Moyinkum	456,0 351,0	Moyynkum, Sarysusky (RK)
	Subaquial		Ulanbel	266,0	Sarysusky (RK)

At the same time, the catchment area of the Shu river basin, as a model of an «activity-natural system», including four categories: activity (A), natural material (NM), transformation of material (TM) and the formation of anthropogenic material (FAM), performing runoff, environment-forming, ecological and social functions, which are the spatial bases of nature management, are considered within the framework of cognitive and transformative activities [2,3].

Materials and research methods. On the basis of the study, many years of information and analytical materials «Kyrgyzhydromet» and «Kazhydromet», as well as the Department of State Statistics of the Kyrgyz Republic and the Republic of Kazakhstan, characterizing the formation of water resources and their use for economic sectors in the catchments of the river basin [1].

A quantitative assessment of the ecological situation in the catchment area of river basins can be made as follows, first, one considers the natural environment at the regional or local level, zoning by type of activity, which does not significantly change in the space-time scale $t_i \rightarrow t_O$ (where t_i - past period; t_O - modern period), Activity parameters $\overline{D_i}$ - are expressed as shares of the total volume of natural resources that were influenced by various factors (Φ_i), Within the limits of each anthropogenic activity, the reduced coefficients of negative reaction for a person are estimated - $\overline{NR} = NR_i/NR_{\max}$ and for its habitat - $\overline{nr} = nr_i/nr_{\max}$ [2-5],

The quantities $\overline{NR}$ and $\overline{nr}$ range from 0 to 1, moreover, an increase in the coefficients indicates a worsening of the situation, Approximate dependencies for assessing the impact of anthropogenic activity have the form [2,3]:

- for human $\overline{NR} = \left(\sum_{1}^{i} \overline{D}_i \cdot q_x \right) \sum_{1}^{i} \varepsilon_i(k)$;

- for its habitat $\overline{nr} = \left(\frac{\overline{D}_{вв}}{\overline{D}_{рв}} + q_x \right) \sum_{1}^{i} \beta \cdot \varepsilon_i(k)$,

where $\overline{D}_i$ - degree of contamination of drinking water with pesticides for supplying the population; $\overline{D}_{вв}$ - level of use for irrigation of river waters; $\overline{D}_{рв}$ - the level of use of return water for irrigation; ε_i - particular parameters of the deterioration of the properties of the components of the natural system (for humans, this is the dynamics of diseases associated with the consumption of polluted water and air pollution - $\varepsilon_i(r)$, for soil, plants and crops - the content of toxic salts in the soil, for groundwater - an increase in their mineralization and level - $\varepsilon_i(k)$); β - correction factor (for soil and groundwater $\beta = 1$, for crops $\beta > 1$); q_x- the intensity of the intake of pesticides and nitrates into soils and groundwater,

Intensity of input of pesticides and nitrates into groundwater ($q_x^{гв}$) and into the soil ($q_x^{п}$) are evaluated by empirical dependencies [1-3,7]:

$$q_x^{гв} = 1 - q_x^n ; \; q_x^n = \exp\left[-(\alpha \cdot q_W + 1 - R_\phi)\right],$$

where α - constant, depending on the type of pesticide; q_w - intensity of infiltration nutrition (in shares of the norm); $R_ф$ - infiltration resistance, which is determined by the formula: $R_ф = 1/fm$, here fm - the relative area occupied by soils with low soil thickness (or fine earth),

An approximate assessment of the ecological state of the object can be carried out using the available studies [83], by dependencies:

$$\overline{Э} = 1 - q_x^n = 1 - \exp\left[-(\alpha \cdot q_W + p_i\right],$$

where p_i - parameter characterizing a complex of natural conditions.

Thus, the proposed methodological approach for constructing the ecological profile of the catchment area of the Shu river basin in the context of anthropogenic activity allows three main aspects in the field of nature management and environmental management: the ecological and economic function of river basins associated with the outflow and degradation of renewable natural resources; ecological and biological function of river basins, caused by the destabilization of the biological species Hono-Sapience as a result of the growth of anthropogenic impact and changes in the state of the natural environment; the social function of river basins, which is caused by the contradictions between the global (regional) manifestation of pollution and degradation of the natural environment and a private approach to their solution [6-8].

Research results. On the basis of systematization and analysis of long-term information and analytical materials «Kyrgyzhydromet» and «Kazhydromet», as well as the Department of State Statistics of the Kyrgyz Republic and the Republic of Kazakhstan, characterizing the formation of water resources and their use for economic sectors [1], an idea of the «activity-natural system» was obtained the catchment area of the Shu river basin, to build their ecological profile in the conditions of anthropogenic activity (table 2).

Table 2 – Ecological zoning of the Shu river basin

№	Indicators	Natural areas and landscape catena			
		mountain (eluvial)	Foothill (trans eluvial)	Foothill plain (trans-aqual)	plain (super aquatic)
1	2	3	4	5	6
0	Landscape area (F), mln, ha	15,00	20,80	25,78	138,78
Under natural conditions, (1920 y.)					
1	Agricultural landscape area (F_O), thousands ha.	–	2,08	2,57	13,88
2	Hydrothermal coefficient - $\bar{R}$	0,52-1,16	1,16-1,61	1,70-4,80	7,10-12,6
3	The intensity of the water cycle ($\bar{g} = \exp(-1.5 \cdot \bar{R})$)	0,2837	0,2516	0,0388	0,0001

Continuation of table 2

1	2	3	4	5	6
4	The intensity of the intake of pesticides and nitrates into the soil (q_x^n)	0,5326	0,6378	0,9139	0,9512
5	Intensity of chemicals and nitrates entering groundwater ($q_x^г$)	0,4674	0,3622	0,0861	0,0488
6	The coefficient of a person's negative reaction to man-made impacts ($\overline{NR}$)	0,0000	0,0506	0,0113	0,0067
7	Coefficient of negative reaction of the environment to technogenic impact ($\overline{nr}$)	0,0000	0,1275	0,2284	0,2378
8	Assessment of the ecological state of the object – $\overline{Э} = 1 - q_x^n$	0,4674	0,3622	0,08100	0,0488
9	The volume of wastewater discharged into the river ($W_в$), км^3	0,000	0,000	0,115	0,327
10	River water volume (W_p), km^3	0,851	1,328	1,151	1,637
11	Mineralization of return waters ($C_в$),g / l	0,00	0,00	1,00	1,50
12	Degree of environmental degradation ($\overline{Э} = 1 - \exp(-q_x^n \cdot C_в \cdot V_в)$	0,00	0,00	0,01	0,02
At the beginning of anthropogenic activity (1960 y.)					
1	Agricultural landscape area (F_O), thousands. ha	-	10,0	238,0	60,00
2	Hydrothermal coefficient - $\bar{R}$	0,52-1,16	1,10-1,30	0,70-0,90	0,65-0,70
3	The intensity of the water cycle ($\bar{g} = \exp(-1.5 \cdot \bar{R})$	0,2837	0,1653	0,2725	0,3642
4	Intensity of input of pesticides and nitrates into the soil (q_x^n)	0,5326	0,6977	0,7261	0,6637
5	Intensity of chemicals and nitrates entering groundwater ($q_x^г$)	0,4674	0,3023	0,2739	0,3363
6	The coefficient of a person's negative reaction to man-made impacts ($\overline{NR}$)	0,0000	0,0560	0,0608	0,0995
7	Coefficient of negative reaction of the environment to technogenic impact ($\overline{nr}$)	0,0000	0,1744	0,2178	0,2655
8	Assessment of the ecological state of the object - $\overline{Э} = 1 - q_x^n$	0,4674	0,3023	0,2739	0,3363
9	The volume of wastewater discharged into the river ($W_в$), km^3	0,000	0,095	0,560	0,120
10	River water volume (W_p), km^3	1,148	2,264	2,923	4,378
11	Return water salinity ($C_в$), g/l	0,00	1,00	2,20	2,50
12	Degree of environmental degradation ($\overline{Э} = 1 - \exp(-q_x^n \cdot C_в \cdot V_в)$	0,000	0,030	0,260	0,050
During the period of increased intensity of anthropogenic activity (1980 y.)					
1	Agricultural landscape area (F_O), thousands. ha		20,0	343,0	80,0
2	Hydrothermal coefficient - $\bar{R}$	0,52-1,16	1,15-1,20	0,80-0,90	0,60-0,80
3	The intensity of the water cycle ($\bar{g} = \exp(-1.5 \cdot \bar{R})$	0,2837	0,1720	0,2780	0,3499
4	Intensity of input of pesticides and nitrates into the soil (q_x^n)	0,5326	0,6907	0,7189	0,6703
5	Intensity of chemicals and nitrates entering groundwater ($q_x^г$)	0,4674	0,3093	0,2811	0,3297
6	The coefficient of a person's negative reaction to man-made impacts ($\overline{NR}$)	0,0000	0,2260	0,2446	0,3155
7	Coefficient of negative reaction of the environment to technogenic impact ($\overline{nr}$)	0,0000	0,2210	0,3594	0,4357
8	Assessment of the ecological state of the object - $\overline{Э} = 1 - q_x^n$	0,4674	0,3093	0,2811	0,3297
9	The volume of wastewater discharged into the river ($W_в$), km^3	0,000	0,200	0,950	0,250
10	River water volume (W_p), km^3	0,844	1,720	2,356	3,622

Continuation of table 2

1	2	3	4	5	6
11	Return water salinity ($C_в$), g/l	0,00	1,50	2,80	3,20
12	Degree of environmental degradation ($\bar{Э} = 1 - \exp(-q_x^n \cdot C_в \cdot V_в)$)	0,000	0,110	0,550	0,140
	During the formation of increased anthropogenic activity (2000 y.)				
1	Agricultural landscape area (F_O), thousands. ha	-	15,0	292,0	60,0
2	Hydrothermal coefficient - $\bar{R}$	0,52-1,16	1,10-1,15	0,80-0,90	0,70-0,90
3	The intensity of the water cycle ($\bar{g} = \exp(-1.5 \cdot \bar{R})$)	0,2837	0,2516	0,3570	0,4493
4	Intensity of input of pesticides and nitrates into the soil (q_x^n)	0,5326	0,6378	0,6703	0,6065
5	Intensity of chemicals and nitrates entering groundwater ($q_x^г$)	0,4674	0,3622	0,3297	0,39350
6	The coefficient of a person's negative reaction to man-made impacts ($\overline{NR}$)	0,0000	0,3151	0,3165	0,4013
7	Coefficient of negative reaction of the environment to technogenic impact ($\overline{nr}$)	0,0000	0,3827	0,53262	0,5155
8	Assessment of the ecological state of the object - $\bar{Э} = 1 - q_x^n$	0,4674	0,36220	0,32970	0,39350
9	The volume of wastewater discharged into the river ($W_в$), km^3	0,000	0,089	0,600	0,105
10	River water volume (W_p), km^3	0,747	0,448	1,536	0,703
11	Return water salinity ($C_в$), g/l	0,00	0,90	1,80	2,90
12	Degree of environmental degradation ($\bar{Э} = 1 - \exp(-q_x^n \cdot C_в \cdot V_в)$)	0,160	0,110	0,370	0,230
	During the formation of a very increased anthropogenic activity (2020 y.)				
1	Agricultural landscape area (F_O), thousands. ha	–	15,0	292,0	60,0
2	Hydrothermal coefficient - $\bar{R}$	0,52-1,16	1,20-1,30	1,0-1,15	1,10-1,20
3	The intensity of the water cycle ($\bar{g} = \exp(-1.5 \cdot \bar{R})$)	0,2837	0,1526	0,1999	0,1791
4	Intensity of input of pesticides and nitrates into the soil (q_x^n)	0,5326	0,7047	0,7738	0,7945
5	Intensity of chemicals and nitrates entering groundwater ($q_x^г$)	0,4674	0,2853	0,2262	0,2055
6	The coefficient of a person's negative reaction to man-made impacts ($\overline{NR}$)	0,0000	0,3007	0,3257	0,3124
7	Coefficient of negative reaction of the environment to technogenic impact ($\overline{nr}$)	0,1600	0,4228	0,5417	0,6753
8	Assessment of the ecological state of the object - $\bar{Э} = 1 - q_x^n$	0,4674	0,2853	0,2262	0,2055
9	The volume of wastewater discharged into the river ($W_в$), km^3	0,000	0,150	0,700	0,200
10	River water volume (W_p), km^3	0,851	1,523	1,416	0,968
11	Return water salinity ($C_в$), g/l	0,00	1,10	2,10	3,20
12	Degree of environmental degradation ($\bar{Э} = 1 - \exp(-q_x^n \cdot C_в \cdot V_в)$)	0,000	0,070	0,550	0,460

Based on the forecast calculation performed to assess the ecological situation in the catchment area of the Shu river basin on a spatial-temporal scale, it was concluded that for the period under consideration (1920-2020), the qualitative state of the ecological profile largely depends on the altitudinal zonation characterizing the class of landscapes in river basins:

- in the zone of the mountainous landscape class (eluvial facies), due to the absence of directed anthropogenic activity for the transformation and improvement of natural resources of the natural system, where changes in the components of the natural system occur under the influence of only natural processes, the preservation of their ecological stability and deterioration of the ecological situation are not observed, which are supported by the peculiarity of the biological cycle, which are formed according to the type of accumulative balance, on the other hand, by the removal of a part of the accumulated substance during the biological active period of the year by geostocks (zone of natural regulation);

- in the zone of the foothill landscape class (transeluvial facies), insignificant anthropogenic activity for the transformation and arrangement of the natural system, where changes in the components of the natural system occur under the influence of not only natural, but also man-made processes, leads to some changes in the components of the natural system, which due to self-regulating their ability, provides natural environmental sustainability, however, some changes in the environmental situation are observed, that is, the indicator of the degree of deterioration of the environmental situation ranges from 0.00 to 0.110 (the zone of controlled and accounted for the consequences of anthropogenic activity)

- in the zone of the foothill lowland subclass of the landscape (trans-accumulative facies), which is the basis of spatial nature management, there is a high tendency of anthropogenic activity, large-scale changes occur, due to the transformation and nature management of the components of the natural system, for the economic and ecological functions of river basins, not only natural services are provided, but also technogenic services, leads not only to an increase in the intensity of biological as well as geological cycles of water and chemicals, and, therefore, the integrity of the natural system of river basins, which led to a deterioration of their ecological situation, where the indicator of the degree of deterioration of the ecological situation ranges from 0.01 to 0.550 (zone of uncontrolled, not considered consequences of anthropogenic activity);

- in the zone of the plain landscape class (superaquial and subaquial facies), which is the basis for spatial nature management and geochemical runoff, there is a growth rate of not only anthropogenic activity, but also technogenic loads, which are accompanied by negative consequences, always lead to a violation of the basic properties of the components of the natural system in the lower reaches river basins, that is, the indicator of the degree of deterioration of the ecological situation ranges from 0.02 to 0.460 (zone of controlled and accounted for the consequences of anthropogenic activity);

Conclusions. The functioning of the catchment area of the Shu River basin, as a geographic object that performs environment-forming, ecological and social functions and is the spatial basis of nature management in conditions of anthropogenic activity, was considered on the basis of systematization and analysis of long-term information and analytical materials «Kyrgyzhydromet» and «Kazhydromet», as well as statistics of the Kyrgyz Republic and the Republic of Kazakhstan, characterizing the formation of water resources and their use for economic sectors [], made it possible, within the framework of cognitive and transformative activities, to build their ecological profile on a spatial and temporal scale, which allows making a number of decisions at the state and interstate levels aimed to regulate relations in the spheres of water use, environmental, economic and social issues arising from the joint use of water resources of transboundary watercourses.

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АНТОРОПЕГЕНДІК ҚЫЗМЕТ ЖАҒДАЙЫНДА ШУ ӨЗЕНІНІҢ СУ ЖИНАУ АЛАБЫНЫҢ ЭКОЛОГИЯЛЫҚ БЕЙІНІ

Аннотация. Қырғыз Республикасының «Қырғызгидромет» және Қазақстан Республикасының «Қазгидромет», сонымен қатар Мемлекеттік статистика департаменттерінің Шу өзенінің су жинау алабындағы су ресурстарының қалыптасуын және оны экономика саласына пайдалануды сипаттайтын көпжылдық ақпараттық-талдау мәліметтерінің негізінде өзен алабының су ағыны мен ортасын құрушы, экологиялық, экономикалық қызметтерді атқаратын және табиғатты пайдаланудың кеңістік базисі саналатын «қызметтік-табиғи жүйе» үлгісі ретінде қарастыру арқылы аймақ жағдайына және су нысандарына кешенді бағалау жұмыстары қарастырылған. Шу өзенінің су жинау алабының негізгі қызметтерін бағалау үшін аймақтағы

антропогендік қызмет қарқынын және бағытын анықтайтын, танымдық және түрлендіру қызметінің даму беталысын айқындауға мүмкіндік беретін геожүйелік әдісін пайдалану арқылы геоморфологиялық жүйелеудің ғылыми және тәжірбелік мақсаттының негізінде, экологиялық бейнесін кеңістік-уақыт масштабында тұрғызу жолы негізделген. Өзен алабының негізгі қызметі – бір ғана жеңілдеу нысаны бар гидрогеохимиялық ағынды қалыптастыру, Шу өзенінің су жинау алабының экологиялық бейнесінің сапалық жағдайын анықтай отырып, яғни белдеулік заңдылықтарға байланысты Ландшафттың таулы тобынан ландшафтардың жазықтық тобына (супераквиальдық және субаквиальдық фацияға) дейін, әсіресе, ауылшаруашылық және өндірістік нысандардың қайтарма (коллектор-кәріз) суын жинайтын аймақ болып саналатын өзен алабының төменгі саласында табиғи гидрологиялық тербеліс бұзылатындықтан, аймақтың гидрогеологиялық және топырақ-мелиоративтік үдерісіне және экологиялық жағдайына үлкен әсер тигізеді.

Түйін сөздер: өзен, су жинау алабы, ағын, жүйе, үлгі, функция, қызмет, түрлендіру, таным, экология, бейне, желілеу, талдау, бағалау.

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ЭКОЛОГИЧЕСКИЙ ПРОФИЛЬ ВОДОСБОРА БАССЕЙНА РЕКИ ШУ В УСЛОВИЯХ АНТРОПОГЕННОЙ ДЕЯТЕЛЬНОСТИ

Аннотация. На основе проведенного исследования многолетние информационно-аналитические материалы «Кыргызгидромета» и «Казгидромета», а также Департамента государственной статистики Кыргызской Республики и Республики Казахстан, характеризующие формирование водных ресурсов и их использование в хозяйственных секторах водосборного бассейна реки Шу, были рассмотрены в качестве модели "деятельность-природная система", осуществляющей сток, природообразующую деятельность., эколого-социальные функции и является пространственной основой природопользования для комплексной оценки состояния территории и водных объектов. В качестве основы оценки основных функций водосбора бассейна реки Шу был использован геосистемный подход, определяющий научно-практическую целесообразность геоморфологической схематизации, в рамках которой становится возможным построение их экологического профиля в пространственно-временном масштабе, что позволяет установить тенденции развития познавательной и преобразующей деятельности, определяющие направленность и интенсивность антропогенной деятельности в регионе. Основная природная функция речного бассейна – формирование гидрогеохимического потока, имеющих один объект для своей разгрузки, определяет качественное состояние экологического профиля водосбора бассейна реки Шу, то есть в зависимости от поясности от горного класса ландшафтов до равнинного класса ландшафтов (супераквиальная и субаквиальная фация) постепенно нарушаются природные гидрологические ритмы, оказывает влияние на гидрогеологические и почвенно-мелиоративные процессы и экологические обстановки, особенно в низовьях речных бассейнов, являющихся зонами магазинирования возвратных (коллекторно-дренажных и сточных) вод промышленных и сельскохозяйственных объектов.

Ключевые слова: река, водосбор, бассейн, сток, система, модель, функция, деятельность, преобразования, познание, экология, профиль, схематизация, анализ, оценка.

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