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Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

# Х А Б А Р Л А Р Ы

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## ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
РЕСПУБЛИКИ КАЗАХСТАН  
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## NEWS

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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. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.*

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

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## **QUANTITATIVE AND QUALITATIVE ASSESSMENT OF BIOLOGICAL AND ECOLOGICAL POTENTIAL OF THE LANDSCAPES OF SOUTHERN KAZAKHSTAN**

**Abstract.** The paper considers methodological approaches to assessment of biological and environmental potential of landscape systems in the southern Kazakhstan soil-climatic conditions to the most complete and efficient use of natural resources in the design and construction of high-performance agrolandscape systems. Based on qualitative and quantitative indicators heat, light and moisture availability a mathematical model has been developed to assess biological and environmental productivity of landscape systems including soil productivity and vegetation cover.

It should be noted that the developed model of landscapes biological productivity assessment ( $C_{bp}$ ) takes into account the heat availability of the landscape systems soil cover ( $C_{tb}$ ), natural moisturization coefficient of the vegetation cover ( $C_m$ ), and ecological productivity of landscapes ( $C_{bp}$ ). This model is based on the potentially available energy expended in soil-forming process ( $Q_n$ ) and natural moisturization coefficient of the vegetation cover ( $C_m$ ) is one of the modifications of the qualitative and quantitative models of natural system climatic productivity, widely used in the field of geography and ecology assessment of natural system resources potential.

Based on the developed models of landscape systems biological and environmental productivity a comprehensive assessment of South Kazakhstan region natural resource potential was performed, including Almaty, Zhambyl, Kyzylorda and Turkestan region using long-term data of 32 meteorological stations located on the territory of the region.

Use of improved methodologies for assessment of landscape systems biological and ecological productivity can more accurately determine the biological resources of the landscape systems according to agro-ecological areas and to assess the efficiency of natural system natural resources potential.

**Keywords:** nature, landscape, climate, productivity, biology, ecology, potential, index.

**Introduction.** To solve the problems of rational distribution of agriculture productive forces and designing high-performance agrolandscape systems, it is necessary to have a detailed landscapes descriptions by the most important factors characterizing heat and moisture availability, plant and soil covers, expressed in the form of some mathematical models to evaluate their natural resource potential.

Existing methodological approaches and methods of the climate productivity assessment do not adequately reflect the productivity of landscape systems, i.e., vegetation and soil cover, there is a need to develop methods of complex biological and ecological assessment of the landscapes productivity on the basis of the fundamental laws of nature, which must include a private assessment of its components productivity, that is, soil and vegetative cover productivity.

Biological and environmental assessment productivity landscapes should be understood as a comprehensive assessment using the integral characteristics of climate, soil and environmental factors positively influencing the growth and development of plants in certain geographic areas representing energy

resources of natural systems. At the same time environmental assessment of landscapes productivity should be based on the use of geographical regularities manifested in the scale of territorial units of different hierarchical ranks, that is, in geo-ecological, environmental and landscape systems, which gives the possibility to explain the nature of the formation and functioning of landscape systems in specific climatic zones [1, 2].

**Purpose of this study** is to develop integrated models to assess biological and ecological productivity of landscapes, including plant productivity and soil conditions, allowing to use of qualitative and quantitative indicators of heat and moisture availability and to determine the regularities of formation and functioning of natural systems depending on the latitudinal zonation and altitudinal belts for the effective distribution of productive forces of agricultural sector.

**Methods.** Model development and assessment of biological and ecological capacity of natural system landscapes is based on the methodology of systemic researches in the field of biology, geography and ecology, as well as on the methods of mathematical modelling of natural process.

Long-term data of meteorological monthly bulletins at the meteorological stations of southern Kazakhstan, submitted to "Kazgidromet" RSE is used to assess the biological and ecological capacity of southern Kazakhstan natural systems landscapes [3, 4].

**Results.** Energy characteristics of the natural system are used for quantitative assessment of biological and ecological potential of landscapes, that is, the formation of the production process of the vegetative and soil covers in the landscape systems, that is: sum of air temperatures ( $\Sigma t$ ) above 10°C, the amount of moisture deficit of air ( $\Sigma d$ , mb), evaporation ( $E_o$ , mm), photosynthetic active radiation ( $R$ , kJ/cm<sup>2</sup>) and the sum of precipitation ( $O_c$ , mm) (table 1) [4-10].

As can be seen from table 1, energy resources of South Kazakhstan landscape systems are very high, as the sum of biologically active temperatures ( $\Sigma t, ^\circ C$ ) is in the range of 1737-4419°C, the sum of air humidity deficit ( $\Sigma d$ ) – 1190-4240 mb, evaporation ( $E_o$ ) – 521-1325 mm and photosynthetic active radiation ( $R$ ) - 115,8-204.6 kJ/cm<sup>2</sup>, which have inverse dependences to the absolute height ( $H$ , m) of meteorological stations location. Precipitation ( $O_c$  - 151-509 mm) has a direct dependence, showing strict obedience to the laws of geographic zonality, which allows to use them for quantitative and qualitative assessment of biological and environmental productivity of vegetation and soil cover of southern Kazakhstan landscape systems.

Methodology for biological and environmental assessment of landscapes agricultural productivity was used for agroclimatic assessment of the landscapes productivity. This approach is used in mathematical models of plant and soil productivity of J. C. Mustafayev and G. A. Adilbektegi These models are based on the concept of maximum productivity. Similar studies conducted by scientists of CIS and foreign countries [11-20].

Biological productivity according to the official definition of the International coordinating committee on terminology and concepts in the field of production studies, is a set of processes of creation, transformation, absorption and transmission of energy through ecological and biological systems of different levels – from individual organisms to biogeocoenosis (ecosystems). The study of biological productivity of natural systems is a necessary basis of rational use, protection and reproduction of biological resources of the Earth.

To assess heat availability of landscape systems vegetation cover you can use the average annual amount of biologically active air temperatures of the  $\Sigma t_i, ^\circ C$  i region to the average maximum possible biologically active sums of air temperatures in the  $\Sigma t_{\max}, ^\circ C$  region, that is:  $C_{ts} = \Sigma t_i / \Sigma t_{\max}$ . Expected productivity of vegetation, depending on the heat availability of landscape systems are determined by indicators ( $C_{tb}$ ) characterizing favorable temperature regime of the natural system (1):

$$C_{tb} = 1 - C_{ts} = 1 - (\Sigma t_i / \Sigma t_{\max}), \quad (1)$$

To assess the moisture availability of the landscape systems soil cover you can use the natural moisturizing factor of N. N. Ivanov (2):

$$C_m = O_c / E_o, \quad (2)$$

where  $O_c$  is precipitation, mm;  $E_o$  - evaporation rate, determined by the formula of N.N. Ivanov (3) [8]:

Table 1 – Natural energy resources of Southern Kazakhstan landscape systems

Weather stations	Absolute height ( $H$ ), m	Indicators of natural and energy resources				
		$\Sigma t$ , °C	$\Sigma d$ , mb	$E_o$ , mm	$R$ , kJ/cm <sup>2</sup>	$O_c$ , mm
Almaty region						
Uch-Aral	395	3294	2452	988	167,4	385
Sarkand	764	3163	2217	949	163,0	535
Taldykurgan	601	3173	2315	952	163,3	412
Bakanas	396	3525	2962	1058	175,0	223
Zharkent	641	3631	2396	1089	178,5	191
Chilik	606	3623	2559	1089	178,2	298
Almaty	671	3007	1370	902	157,9	509
Narynkol	1806	1737	1190	521	115,8	433
Sary-Ozek	548	2134	2257	640	129,0	332
Zhambyl region						
Ulanbel	266	3721	3050	1116	181,5	224
Moiynqum	350	3506	2553	1052	174,4	294
Uyuk	373	3720	3203	1116	181,5	283
Otar	742	3116	2635	935	161,5	316
Kurdai	1141	2930	2214	879	155,3	290
Kulan	682	3386	2519	1051	170,4	361
Taraz	642	3492	2309	1048	173,9	353
Merke	703	3472	2513	1041	173,2	435
Zhualy	952	2766	2022	830	149,9	447
Turkestan region						
Suzak	316	3822	3541	1147	184,8	186
Turkestan	206	4350	4197	1305	202,3	238
Tyulkubas	789	3876	3233	1163	186,6	951
Arys	237	4419	4240	1325	204,6	275
Shymkent	543	4065	3382	1219	192,9	582
Shardara	238	4397	4168	1391	203,9	264
Tolebi	455	3655	2605	1096	179,3	336
Kyzylorda region						
Saksaul	78	3647	3233	1094	179,0	152
Aral sea	62	3524	2633	1057	175,0	166
Qazaly	66	3647	2733	1094	179,0	178
Zhusaly	101	3809	3403	1142	184,4	165
Kyzylorda	128	3766	3160	1129	183,0	151
Shieli	152	3883	3154	1165	186,8	174
Ak-Kum	173	4253	3861	1276	199,1	204

$$E_o = 0.0018(25 + t)^2(100 - a), \quad (3)$$

where  $t$  - the average monthly air temperature, °C;  $a$  - average monthly relative humidity, %.

Thus, biological assessment of landscapes productivity ( $C_{bp}$ ) is determined by the ratio of such averaged indicator values as plant ( $C_{tb}$ ) and soil ( $C_m$ ) productivity factors (4):

$$C_{bp} = C_{tb} \cdot C_m, \quad (4)$$



To determine the biological productivity of landscape systems in southern Kazakhstan and its agro-ecological regions the information-analytical materials presented in table 1(table 2) were used as potential indicators.

As can be seen from table 2, the qualitative and quantitative values of biological productivity of plant ( $C_{ib}$ ) and soil ( $C_m$ ) covers, as well as the biological productivity of landscapes ( $C_{bp}$ ) is strictly subject to the laws of geographic zonality, that is directly dependent on the absolute height ( $H$ ) location of landscape systems.

Table 2 – Evaluation of southern Kazakhstan and its agro-ecological regions landscape systems biological productivity

Weather stations	Absolute height ( $H$ ), m	Indicators of energy resources			$C_m$	$C_{bp}$
		$\Sigma t$ , °C	$C_{ts}$	$C_{ib}$		
Almaty region						
Uch-Aral	395	3294	0,74	0,26	0,19	0,050
Sarkand	764	3163	0,72	0,28	0,28	0,078
Taldykurgan	601	3173	0,72	0,28	0,22	0,062
Bakanas	396	3525	0,80	0,20	0,11	0,022
Zharkent	641	3631	0,82	0,18	0,13	0,023
Chilik	606	3623	0,82	0,18	0,10	0,018
Almaty	671	3007	0,68	0,32	0,35	0,112
Narynkol	1806	1737	0,39	0,61	0,65	0,396
Sary-Ozek	548	2134	0,48	0,52	0,23	0,120
Zhambyl region						
Ulanbel	266	3721	0,34	0,66	0,10	0,066
Moiynqum	350	3506	0,79	0,310	0,13	0,040
Uyuk	373	3720	0,84	0,16	0,12	0,019
Otar	742	3116	0,71	0,19	0,22	0,042
Kurdai	1141	2930	0,66	0,34	0,30	0,102
Kulan	682	3386	0,77	0,23	0,21	0,070
Taraz	642	3492	0,79	0,21	0,20	0,042
Merke	703	3472	0,79	0,21	0,29	0,061
Zhualy	952	2766	0,63	0,37	0,23	0,099
Turkestan region						
Suzak	316	3822	0,86	0,14	0,09	0,013
Turkestan	206	4350	0,98	0,02	0,08	0,002
Tyulkubas	789	3876	0,88	0,12	0,22	0,026
Arys	237	4419	0,99	0,01	0,08	0,001
Shymkent	543	4065	0,92	0,08	0,15	0,012
Shardara	238	4397	0,99	0,01	0,08	0,001
Tolebi	455	3655	0,83	0,17	0,17	0,029
Kyzylorda region						
Saksaul	78	3647	0,83	0,17	0,08	0,014
Aral sea	62	3524	0,80	0,20	0,16	0,034
Qazaly	66	3647	0,82	0,18	0,08	0,014
Zhusaly	101	3809	0,86	0,14	0,06	0,008
Kyzylorda	128	3766	0,85	0,15	0,07	0,011
Shieli	152	3883	0,88	0,12	0,06	0,007
Ak-Kum	173	4253	0,96	0,04	0,06	0,002

Ecological productivity of landscapes is closely connected with the flow of energy passing through a particular ecosystem, that is, falling to the trophic chain. Energy is accumulated as organic compounds, which provide continuous production of biomass (living matter). This is one of the fundamental processes of the biosphere.

Energy consumed for soil formation, defined by the formula of V.P. Volobuyev [6] characterizes the productivity of the soil landscapes to some extent (5):

$$Q_i = R \cdot \exp(-\alpha_o \cdot \bar{R}), \quad (5)$$

where  $Q_i$  - energy consumed for soil formation, kJ/cm<sup>2</sup>;  $\alpha_o$  - coefficient taking into account the soil surface condition.

Table 3 – Evaluation of southern Kazakhstan and its agro-ecological regions landscape systems biological productivity

Weather stations	Absolute height (H), m	Energy costs on soil formation ( $Q$ , kJ/cm <sup>2</sup> )			$C_m$	$C_{bp}$
		where $\bar{R}_i$	where $\bar{R} = 1.0$	$C_p$		
Almaty region						
Uch-Aral	395	60,9	104,6	0,58	0,19	0,11
Sarkand	764	92,2	101,9	0,90	0,28	0,25
Taldykurgan	601	77,9	101,9	0,76	0,22	0,17
Bakanas	396	40,0	109,4	0,37	0,11	0,04
Zharkent	641	56,5	108,8	0,52	0,13	0,07
Chilik	606	56,4	111,4	0,51	0,10	0,05
Almaty	671	51,5	98,7	0,52	0,35	0,21
Narynkol	1806	70,2	72,4	0,97	0,65	0,76
Sary-Ozek	548	62,1	80,6	0,77	0,23	0,18
Zhambyl region						
Ulanbel	266	39,7	113,4	0,35	0,10	0,04
Moiynqum	350	57,6	109,0	0,53	0,13	0,07
Uyuk	373	54,4	113,4	0,48	0,12	0,07
Otar	742	54,4	109,3	0,74	0,22	0,19
Kurdai	1141	71,9	97,1	0,53	0,30	0,16
Kulan	682	69,9	106,5	0,56	0,21	0,15
Taraz	642	68,8	108,7	0,53	0,20	0,14
Merke	703	82,6	108,6	0,76	0,29	0,26
Zhualy	952	79,8	93,7	0,85	0,23	0,20
Turkestan region						
Suzak	316	28,8	115,5	0,25	0,09	0,04
Turkestan	206	40,8	126,4	0,32	0,08	0,01
Tyulkubas	789	130,2	116,6	1,00	0,22	0,22
Arys	237	54,5	127,9	0,43	0,08	0,03
Shymkent	543	74,6	120,6	0,52	0,15	0,07
Shardara	238	47,8	127,3	0,38	0,08	0,03
Tolebi	455	66,0	112,0	0,59	0,17	0,11
Kyzylorda region						
Saksaul	78	19,6	111,8	0,18	0,08	0,01
Aral sea	62	24,4	109,4	0,22	0,16	0,04
Qazaly	66	27,0	111,9	0,24	0,08	0,02
Zhusaly	101	22,3	115,3	0,19	0,06	0,01
Kyzylorda	128	18,9	114,4	0,16	0,07	0,01
Shieli	152	25,0	116,8	0,21	0,06	0,01
Ak-Kum	173	31,9	114,4	0,26	0,06	0,01

In a natural system, the principle of energy balance of heat and moisture is observed in natural conditions, where the radiation index of dryness ( $\bar{R}$ ) is equal to 1.0. Therefore, the limit in the range of 0.9-1.0 can be taken as a criterion of the radiative index of dryness ( $\bar{R}$ ).

Then, the potential energy expended on soil-forming process ( $Q_n$ ), providing the potential productivity of the soil can be determined by expression (6):

$$Q_n = R \cdot \exp(-0.9 \cdot \alpha_o) . \quad (6)$$

Consequently, the ratio of energy consumed for soil formation under natural conditions ( $Q_i$ ) to the potential energy expended in soil-forming process ( $Q_n$ ) represents the productivity of the landscapes soil cover, i.e. (7), [7]

$$C_p = Q_i/Q_n, \quad (7)$$

Thus the natural moisturizing factor of N. N. Ivanov [8] can be used to evaluate the productivity of vegetation landscape systems (8):

$$C_m = O_c/E_o . \quad (8)$$

Thus, the ecological productivity of landscapes ( $C_{ep}$ ) is determined by the ratio of such averaged indicator values as an indicator of the soil surface productivity ( $C_p$ ) and the natural moisturization coefficient, which characterizes the productivity of vegetation ( $C_m$ ) (9):

$$C_{ep} = C_m \cdot C_p . \quad (9)$$

On the basis of information and analytical materials presented in table 1, which characterize energy resources and heat and moisture availability of southern Kazakhstan landscape systems, environmental productivity ( $C_{ep}$ ) of the landscape of South of Kazakhstan and its agro-ecological regions (table 3) is defined.

As can be seen from table 3, the analysis of the plant ( $C_m$ ) and soil ( $C_p$ ) covers ecological productivity calculation results, as well as ecological productivity of landscapes ( $C_{bp}$ ), indicates that their qualitative and quantitative values, and biological productivity of landscapes, strictly obey the laws of geographic zonality and decrease with decreasing altitude (H) of landscape systems location.

Thus, the developed model of landscapes biological and ecological productivity climate index allows, first, to give quantitative values of qualitative changes of habitats; secondly, to assess the modelling the transformation of natural systems under climate change; third, to conduct landscape-ecological zoning of the natural systems that can be used to assess the biological and ecological productivity of landscape systems, allowing the rational location of the agriculture productive forces.

**Discussion.** For the territory of South Kazakhstan, spanning from the mountain foothills to arid desert zones, the most important soil-ecological indices are set, i.e. mathematical models of biological and ecological productivity of landscapes that define the resource potential of the area and productivity of soil and vegetation cover. System for assessing the biological and ecological productivity of landscapes has attempted to carry out a comprehensive accounting of climate, soil and plants which would more fully describe the environment the agricultural sector is operating in.

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#### ОҢТҮСТІК ҚАЗАҚСТАН ЛАНДШАФТТАРЫНЫҢ БИОЛОГИЯЛЫҚ ЖӘНЕ ЭКОЛОГИЯЛЫҚ ӘЛЕУЕТІН САНДЫҚ ЖӘНЕ САПАЛЫҚ БАҒАЛАУ

**Аннотация.** Жұмыста жоғары тиімді агроландшафттық жүйелерді жобалау және құрастыру кезінде табиғи қорларды неғұрлым толық және тиімді пайдалану мақсатында Оңтүстік Қазақстанның топырақ-климаттық жағдайларындағы ландшафттық жүйелердің биологиялық және экологиялық әлеуетін бағалау

жүйесінің әдістемелік тәсілдері қарастырылды. Жылумен, жарықпен және ылғалмен қамтамасыз етудің сапалық және сандық сипаттамалық белгілерінің негізінде, топырақ және өсімдік жамылғысын қамтитын ландшафттық жүйелердің биологиялық және экологиялық өнімділігін бағалауға арналған математикалық үлгі әзірленді.

Ландшафттардың биологиялық өнімділігін бағалауға әзірленген үлгі ( $K_{\text{он}}$ ) ландшафттық жүйелердің топырақ жамылғысының жылумен қамтамасыз етілуін ( $K_{\text{тө}}$ ), өсімдік жамылғысының табиғи ылғалдану дәрежесінің өлшемдік көрсеткішін ( $K_y$ ), сондай-ақ ландшафттардың экологиялық өнімділігін ( $K_{\text{он}}$ ) ескереді. Бұл үлгі топырақты түзуші жүргіге шығын болған қуатына ( $Q_n$ ) және өсімдік жамылғысының табиғи ылғалдану көрсеткішіне ( $K_y$ ) негізделеді және табиғи жүйенің табиғи-әлеуетті қорларын бағалау үшін география және экология саласында кеңінен пайдаланылатын табиғи жүйенің климаттық өнімділігінің сапалық және сандық үлгілерінің бірі болып табылады.

Ландшафттық жүйелердің биологиялық және экологиялық өнімділігін бағалауға арналып әзірленген үлгінің негізінде, құрамына Алматы, Жамбыл, Түркістан және Қызылорда облыстары кіретін Қазақстанның Оңтүстік аймағында орналасқан 32 метеорологиялық бекеттердің көпжылдық деректік мәліметтерін пайдалану арқылы, оның табиғи-қорлық әлеуетін жан-жақты бағалау жүргізілді.

Ландшафттық жүйелердің биологиялық және экологиялық өнімділігін бағалаудың жетілдірілген әдістерін пайдалану агроэкологиялық аудандар бойынша ландшафттық жүйелердің биологиялық қорларын неғұрлым дәл анықтауға және табиғи жүйенің табиғи-қорларының әлеуетін пайдаланудың тиімділігін бағалауға мүмкіндік береді.

**Түйін сөздер:** табиғат, ландшафт, климат, өнімділік, биология, экология, потенциал, индекс.

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## **КОЛИЧЕСТВЕННАЯ И КАЧЕСТВЕННАЯ ОЦЕНКА БИОЛОГИЧЕСКОГО И ЭКОЛОГИЧЕСКОГО ПОТЕНЦИАЛА ЛАНДШАФТОВ ЮЖНОГО КАЗАХСТАНА**

**Аннотация.** В работе рассматриваются методические подходы к системе оценки биологического и экологического потенциала ландшафтных систем в почвенно-климатических условиях Южного Казахстана с целью наиболее полного и эффективного использования естественно-природных ресурсов при проектировании и конструировании высокоэффективных агроландшафтных систем. На основе качественных и количественных индикаторов тепло-, свето- и влагообеспеченности разработана математическая модель для оценки биологической и экологической продуктивности ландшафтных систем, включающая продуктивности почвенного и растительного покровов.

При этом следует отметить, что разработанная модель биологической оценки продуктивности ландшафтов ( $K_{\text{он}}$ ) учитывает теплообеспеченность почвенного покрова ландшафтных систем ( $K_{\text{тө}}$ ), коэффициент естественного увлажнения растительного покровов ( $K_y$ ), а также экологическую продуктивность ландшафтов ( $K_{\text{он}}$ ). Эта модель базируется на потенциально возможной энергии, затраченной на почвообразовательный процесс ( $Q_n$ ) и коэффициент естественного увлажнения растительного покровов ( $K_y$ ), является одним из модификаций качественных и количественных моделей климатической продуктивности природной системы, широко используемых в области географии и экологии для оценки природно-потенциальных ресурсов природной системы.

На основе разработанной модели биологической и экологической продуктивности ландшафтных систем выполнена всесторонняя оценка природно-ресурсного потенциала Южно-Казахстанской области, включающая Алматинскую, Жамбылскую, Туркестанскую и Кызылординскую области с использованием многолетних данных 32 метеорологических станции, расположенных на территории региона.

Использование усовершенствованных методов оценки биологической и экологической продуктивности ландшафтных систем позволяет более точно определить биологические ресурсы ландшафтных систем по агроэкологическим районам и оценить эффективность использования природно-ресурсного потенциала природной системы.

**Ключевые слова:** природа, ландшафт, климат, продуктивность, биология, экология, потенциал, индекс.

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**REFERENCES**

- [1] Mustafayev Z.S., Adilbektegi G.A., Ryabcev A.D. (2007) Methodological basis for assessing the stability and resistance of landscapes. Taraz. ISBN: 9965-724-18-0.
- [2] Mustafayev Z.S., Ryabcev A.D., Kozykeeva A.T., Adilbektegi G.A. (2007) Landscapes and natural and man-made complexes. Taraz. ISBN: 9965-724-19-9.
- [3] Scientific and Applied Reference Book on Climate of the USSR (1989). Series 13, Long-term data. Part 1-6, issue. Book 2. Gidrometeoizdat, Russia (in Russ.).
- [4] Mustafayev Z.S. (2017) Melioration of agricultural land in Kazakhstan [Environmental Engineering] 1: 87-93 (in Russ.).
- [5] Shashko D.I. (1985) To take into account the bioclimatic potential. [Agriculture] 4: 19-26 (in Russ.).
- [6] Volobuyev V.R. (1974) Introduction to the energy of soil formation. M.: Nauka (in Russ.).
- [7] Buscha M., La Notte A., Laporte V., Erhard M. (2012) Potentials of quantitative and qualitative approaches to assessing ecosystem services // Ecological Indicators Journal. 21, 89-103. DOI: 10.1016/j.ecolind.2011.11.010 (in Eng.).
- [8] Ivanov N.N. (1941) Zones of humidification of the globe // Proceedings of the USSR Academy of Sciences. 3: 15-32 (in Russ.).
- [9] Hargrove W.W., Hoffman F.M. (2005). Potential of multivariate quantitative methods for delineation and visualization of ecoregions // Environ. Manag. 34, 39-60. DOI: 10.1007/s00267-003-1084-0 (in Eng.).
- [10] Long J., Nelson T., Wulder M. (2010). Regionalization of landscape pattern indices using multivariate cluster analysis // Environm. Manag. 46, 134-142. DOI: 10.1007/s00267-010-9510-6 (in Eng.).
- [11] Xu Ch., Sheng S., Chi T., Yang X., An S., Liu M. (2014). Developing a quantitative landscape regionalization framework integrating driving factors and response attributes of landscapes // Landscape Ecology Engineering. 10, 295-307. DOI: 10.1007/BF00135075 (in Eng.).
- [12] Raudsepp-Hearne C., Peterson G.D., Bennet E.M. (2010) Ecosystem service bundles for analyzing trade-offs in diverse landscapes // Proceedings of the National Academy of Sciences of the United States of America. 107, 5242-5247. DOI: 10.1073/pnas.0907284107 (in Eng.).
- [13] Perko D., Hrvatin M., Ciglič R. (2015) A methodology for natural landscape typification of Slovenia // Acta geographica Slovenica. 55-2. DOI: 10.3986/AGS.1938 (in Eng.).
- [14] Blum WEH Functions of soil for society and the environment (2005) Functions of soil for society and the environment // Rev Environ Sci Biotechnol. 4(3):75-79. DOI: 10.1007/s11157-005-2236-x (in Eng.).
- [15] Van Eetvelde V., Antrop M. (2009) A stepwise multi-scaled landscape typology and characterization for transregional integration, applied on the federal state of Belgium // Landsc. Urban Plann. 91, 160-170. DOI: 10.1016/j.landurbplan.2008.12.008 (in Eng.).
- [16] Bunce R.G.H., Barr C.J., Clarke R.T., Howard D.C., Lane A.M.J. (1996) Land classification for strategic ecological survey // Journal of environmental management. 47-1. DOI: 10.1006/jema.1996.0034 (in Eng.).
- [17] Kwiatkowska-Malina J. (2018) Qualitative and quantitative soil organic matter estimation for sustainable soil management // Journal of Soils and Sediments. 18: 2801-2812. DOI: 10.1007/s11368-017-1891-1 (in Eng.).
- [18] Coleman D.C., Grys-Rubenstein E. (2014) Biological productivity, AccessScience. DOI:10.1036/1097-8542.082800 (in Eng.).
- [19] Tilman D., Reich P.B., Forest I. (2012) Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory // Proc Natl Acad Sci U S A 109(26): 10394-10397. DOI: 10.1073/pnas.1208240109 (in Eng.).
- [20] Bünemann E.K., Bongiorno G., Zhanguo B., Brussaard L. (2018) Soil quality – A critical review // Soil Biology and Biochemistry. 120:105-125. DOI: 10.1016/j.soilbio.2018.01.030 (in Eng.).

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