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Problems of health sustainability in the context of industrial and innovative development

The Republic of Kazakhstan has achieved significant economic growth and significant results in the country's socio-economic development. However, the implementation of the Programs for Forced Industrial-Innovative Development, the Business Roadmap 2020 and others within the framework of the traditional production and consumption scheme causes a multiple increase in anthropogenic pressures on the regions, including an increase in the seizures of mineral, hydrocarbon, water, land, energy resources, emissions and volumes of pollutants, the growth of new industries and infrastructures, determining their uneven development and increasing the degree of desertification of territories. To date, a number of environmental problems remain unresolved in Kazakhstan, which require a different approach to the development of state environmental policies and sustainable development management models. Let us cite the main factors hampering the country's sustainable development: inefficient resource management; Excessive consumption of natural resources (anthropogenic impact); commodity orientation of the economy; excessive urbanization of territories; deterioration of public health; human capital; imbalance of regional development; low productivity of economic sectors; increase in the number of industrial zones; deficiency of water resources and desertification of territories; environmental pollution; energy intensity of production; low land productivity and crop yields and other factors. In this article, we will consider in the regional aspect such a factor as the health of the population, taking into account the environmental problems and the environmental situation in the region. The article presents the economic and mathematical model of sustainable development management in the context of the regions of the Republic of Kazakhstan.

Keywords: sustainable development, population, health, environmental management, environmental policy.

Many factors play a role in the implementation of the Concept of Sustainable Development of the Republic of Kazakhstan.

Among others, we would like to note, such as: ineffective management of mineral, land, water and biological resources characteristic of our country will ultimately lead to an increase in the scale and rate of loss of the resource potential, which will accordingly limit the economic development and export potential of regions and the republic in whole. Specialists in the field of mineral resources have concluded that the growth in energy consumption will continue in Kazakhstan, and it has believed that in the next 50 years the volume of mining operations will increase more than five times, mainly due to new deposits with processing ores by old technology. There may be an almost complete exhaustion of the explored reserves of oil, gas and other energy resources.

The next, much important factor hampering sustainable development is the low productivity of land resources. The productivity of land and the yield of basic crops (wheat, barley) in Kazakhstan is three times lower than in Canada due to their considerable degradation. Half of the country's agricultural lands had degraded, of which 50 % of arable land, because of which the yield of wheat fell by 36 %. Such a huge amount of land unsuitable for farming had caused by inefficient use, lack of water, anthropogenic impact [1].

Very low economic productivity of water use in agriculture, which is almost 5 times lower than in Russia, while the cost of water for irrigation of rice fields is 10 times higher than in Russia and Canada. Given the current assessment of water demand, Kazakhstan may face an acute shortage of water resources. According to the Committee of Water Resources, by 2030, less than 1/5 of the water resources will be available for economic use. According to international research, about 2 billion US dollars will be needed to meet water needs in cities, settlements, agrarian and industrial sectors [2].

In addition, a certain danger for Kazakhstan is the pollution of the environment by toxic substances. According to international experts, more than 40 thousand children under the age of 10 suffer from neurological disorders due to exposure and significant amounts of lead in the body.

Kazakhstan ranks second among Central Asian countries and Eastern European countries in terms of environmental pollution by organic substances. Air pollution in Kazakhstan is the main cause of more than 6000 deaths per year [3].

The lack of a waste management system leads to uncontrolled landfills of more than 97 % of household and construction waste. The problem of radioactivity remains very serious.

To assess the level of sustainable development, both at the regional and national level, as well as its modeling, a system of indices and indicators has applied, which includes various components. In view of the enormous diversity in the definition of the term «sustainable development» in the interpretations of domestic and foreign scientists dealing with sustainable development management, we will mean sustainable development as a governance model that will ensure a decent level of the well-being of the population and the dynamic development of the economic and social system with the environment.

In connection with this, the issue of public administration arises sharply in conditions of instability, i.e. creation of the Kazakhstan model of sustainable development management.

Based on the analysis, it can be argued that environmental problems accumulated by more than one generation in the foreseeable future will lead to a deterioration in the living conditions of not only future generations, but also of current residents, the quality of their lives, an increase in morbidity in the RK regions, which can not affect the social sphere of the country. In such conditions, the country's economic development cannot be sustainable. This is the triune unity of the economy, ecology and social sphere.

This has confirmed by the work of the American economist and Nobel laureate Simon Kuznets. In his work Economic Growth and Income Inequality of 1955, he argued that economic growth leads first to an increase, and then to a decrease in inequality [4]. About the ecological curve Kuznets started talking in the early 1990's with the filing of Princeton economists Gin Grossman and Alan Krueger, who studied the effects of free oil trade [4]. Instead of an inequality in the ecological curve of Kuznets, pollution of the environment is substituted [5]. The pattern is the same — the growth of GNP at first the ecology worsens: the factories are smoky, the forests are cut down. But then there is a turning point, which the World Bank report explains: «With the increase in revenues, the demand for improving the environment is rising and there are more resources that can be invested in it». In other words, wealthy citizens, firstly, are keenly interested in breathing clean air and swimming in clean water, and secondly, they can afford to spend extra money on the environment.

The ecological curve of S. Kuznets has something to love: in order to save the environment, it is necessary not to strangle the economy, but, on the contrary, to develop it as intensively as possible, without exchanging ecology.

If the S. Kuznets curve works, then developed and developing countries will sacrifice part of their GDP. Not just for the sake of abstract humanism, but for the sake of further economic growth. The global economy will continue to develop, and greenhouse gas emissions will go down. A turning point will appear on the world ecological curve of S. Kuznets [4].

In our work, we attempted to analyze the relationship between the level of environmental pollution and the volume of GDP in Kazakhstan.

The simplified regression equation of the ecological curve has the form:

$$Y_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_4 \overline{GDP}_{it} + \beta_5 \overline{GDP}_{it}^2 + u_{it}, \quad (1)$$

where Y_{it} — polution; $\overline{GDP}_{it}$ three-year moving average values of gross domestic product.

In this case, moving averages are usually included in the model to smooth out short-term fluctuations and highlight major trends or cycles.

Estimate the coefficients of the regression equation by the least squares method. As a result of approximating the data on GRP volumes and air emissions of pollutants in 16 regions of Kazakhstan for the period from 2004 to 2017, the following equation was obtained:

$$Y_{it} = 81{,}47 + 0{,}13 GRP_{it} + 0{,}00004 GRP_{it}^2 + 0{,}03 \overline{GRP}_{it} + 0{,}000005 \overline{GRP}_{it}^2, \quad (2)$$

where Y_{it} — emissions of pollutants emitted from stationary sources into the atmosphere, measured in thousand tons; GRP_{it} — GRP, billion tenge; $\overline{GRP}_{it}$ — three-year moving average values of gross regional product, billion tenge.

Since the coefficient $\beta_2 = -0{,}0000 < 0$, and the coefficient $\beta_1 = 0{,}13 > 0$, then we have a convex upward (∩-shaped) curve that changes its direction with respect to the point of inflection from growth to fall.

By differentiating the GRP index and equating the result to zero, we calculated the gross domestic product in Kazakhstan, for which the pollution volume reaches its maximum. We have received that the peak of pollution comes at a GRP level of 1677,05 billion tenge. Further increase of this indicator in the RK leads to a reduction in emissions of pollutants into the atmosphere.

However, this trend is not traced for a longer period. As a result of processing data on GRP volumes and air emissions of pollutants in 16 regions of Kazakhstan for the period from 2004 to 2017, we obtained the following regression equation:

$$Y_u = 119,8 - 0,07GRP_u + 0,00001GRP_u^2 + 0,15\overline{GRP}_u - 0,00003\overline{GRP_u^2}. \quad (3)$$

In the equation, the coefficient $\beta_2 = -0,0000 > 0$, and the coefficient $\beta_1 = -0,07 < 0$, therefore, The curve is convex downward (U-shaped) and changes its direction with respect to the point of inflection from falling to growth.

In this case, using in the equation the moving averages of gross domestic product volumes, which are usually included in the model to smooth short-term fluctuations and highlight the main trends or cycles, we see a slightly different picture, analyzing the long trend. This, perhaps, is related to the cyclical development of the economy in the long run, which in itself does not contradict the principles of sustainable development.

Since economic growth reflects quantitative changes (in the form of gross domestic product); and sustainable development reflects qualitative positive changes aimed at growth, transformation and transition from one state to another.

Cyclical development of the economy can be defined as a form of its development, as a movement from one macroeconomic equilibrium to another, i.e. transition from one state to another. In this context, the U-shaped curve represents, on the one hand, the phases of the business cycle. However, since cyclicity itself is a form of economic development, the crisis (manifested at the point of recession), in turn, appears as a form of economic development.

Further, it is of practical interest to study the impact of economic development on the level of pollution in various regions of Kazakhstan. To do this, first we will cluster all regions according to two indicators: the amount of emissions of pollutants emitted from stationary sources (thousand tons) into the atmosphere, and the volume of the gross regional product (in billion tenge).

Table presents all regions of Kazakhstan and indicators of the region's environmental and economic development in 2017.

Table

Ecological and economic development of the regions of the Republic of Kazakhstan in 2017

№	Regions	Amount of emissions into the atmosphere (thousand tons)	GRP volume (billions of tenge)
1	Akmola	83,8	942,2
2	Aktyubinsk	125,4	1816,3
3	Almaty	68,4	1665,5
4	Atyrau	138,4	3635,1
5	West Kazakhstan	60,4	1845,8
6	Zhambyl	33,6	864,0
7	Karaganda	572,6	2690,7
8	Kostanai	115,4	1309,7
9	Kyzyl Orda	31,2	1374,0
10	Mangistau	77,5	1880,0
11	South Kazakhstan	56,3	2062,6
12	Pavlodar	650,4	1539,1
13	North Kazakhstan	71,4	747,5
14	East Kazakhstan	124,9	2050,3
15	City of Astana	60,6	3245,4
16	City of Almaty	12,4	6471,8

Note. Compiled from source [6].

To classify regions, we use cluster analysis, which allows us to divide objects into homogeneous groups or clusters for a number of features. Uniform objects are considered, the observed signs of which are in close

proximity to each other. The norm of proximity is the distance metric. To solve our problem, we used the usual Euclidean metric, according to which the distance between observations has calculated by the formula:

$$d_{i,j} = \sqrt{\sum_{k=1}^{p}\left(x_{ki} - x_{kj}\right)^2}\,. \tag{4}$$

Based on the Euclidean metric, the distance between regions 1 and 2 is:

$$d_{1,2} = \sqrt{(83{,}8 - 125{,}4)^2 + (942{,}2 - 1816{,}3)^2} = 875.$$

It is obvious that $d_{1,2} = d_{2,1}$, a $d_{1,1} = 0$.

The distance between the clusters is determined by the principle of the «far neighbor», which is described by the formula:

$$d_{r,q} = \frac{1}{2}d_{l,q} + \frac{1}{2}d_{m,q} + \frac{1}{2}\left|d_{l,q} - d_{m,q}\right|,$$

where $d_{l,q}; d_{m,q}$ — geometric distances between the corresponding clusters.

Thus, the distance between region 2 and the cluster (1 + 8) is:

$$d_{1,(5+10)} = \frac{1}{2}d_{1,5} + \frac{1}{2}d_{1,10} + \frac{1}{2}\left|d_{1,5} - d_{1,10}\right| = \frac{1}{2}\cdot 904 + \frac{1}{2}\cdot 938 + \frac{1}{2}\left|904 - 938\right| = 938.$$

Carrying out similar calculations, we get a new distance matrix.

Again, we find the minimum distance between the objects $d_{11,14}$=70, combine them into a cluster and, by the principle of «far neighbor», determine the distance between clusters. Thus, we again construct the distance matrix.

Also at the workplaces of industrial enterprises, inconsistencies in the normative requirements for illumination had revealed, which in turn can lead to injuries. After all, one of the factors that determine the safe working conditions and contribute to higher labor productivity and production culture is a favorable light climate.

The evaluation of occurrence of the situations provoked by economic activities, technogenic failures and accidents with human casualties or infringements in functioning of geotechnical systems prevails among applied works. Thus, geologic geomorphological con dictions usually act as the factor defining the probability of extreme situations. At presence of multiple observations or the historical data the probability of emergencies of this or that degree is estimated quantitatively, as a number of possible situations in a year or as an inverse value – possibility of an extreme situation occurring once in a certain number of years. The combination of natural and technogenic components of possible catastrophes allows estimating the ecologic geographical position of specific objects and the ecological risk for the corresponding territories.

As a result of the water erosion influence in the given area the size of ecologic economic risk is defined under the expression

$$R = \sum_{i=1}^{n}\left(P P_0 P\left(\frac{q}{y}\right) P(IS))i\right) Y_i \tag{5}$$

where P — is the probability of a fallout of the atmospheric precipitation forming a superficial water flow (the discharge of water with probability of excess is less than 10 %) and erosion; P_0 — is the probability of unfavorable meteorological conditions (rains few days straight) promoting the occurrence of dangerous natural phenomenon; $P(q/\gamma)$ — is the conditional probability of the developed situation for ecological objects (q) in view of quality of the environment (γ); $P(IS)$ — is the probability of potential losses depending on social conditions, scale of influence and destructive force of erosive processes in the area; Y_i — are losses (damage) in the cost expression depending on a degree of erosion influence on ecological objects.

Quantitative characteristics of rain are the layer, du ration and intensity of precipitations, which are random variables in time and space. The factor of the eroding ability of rains assumes revealing of the correlation connection with quantity of the eroded soil or plotting of the probability distribution curves for volume of soil washout (discharge of mudflows). Unfavorable meteorological conditions (UMC), when precipitations fall out during a long interval of time (two days straight), is a very rare event (P_0) but such cases is possible to at tribute to the erosion hazardous. For plain territory the value is P_0=0.3, for intermountain valleys and foothills P_0=0.35, and for mountains P_0=0.5. The probability that two independent events can happen simultaneous (by the quantity of the fallen out precipitations of today and tomorrow) is the product of probabilities of each of these events, i. e. $P_1 = P \cdot P_0$. Thus, characteristics of a storm rain with probability 0,0693 at

UMC in the foothill territory (P_0=0.35) can be expected at their joint realization with probability 0.0243, and in mountains at (P_0=0.5) – 0.0346.

For cartography of ecologic economic risk in territory of economic development of Almaty area are used:

1) The soil erosive map of Kazakhstan (scale 1:2500000), made in the Institute of Soil Science NAN RAC.

2) The map of land utilization (scale 1:1000000), made by the Kazakh branch of VISHAGI.

3) The map of the mudflow danger of the territory of Republic of Kazakhstan (scale 1:1000000), made by Kazakh Scientific Research Institute of Environment and Climate Monitoring. On the soil erosive map of Republic of Kazakhstan, the non-eroded and non-deflated territories had allocated, as well as: water erosion, deflation, joint display of water erosion and deflation [3].

The map of ecologic economic risk for the territory of Almaty area (scale 1:2500000) can serve as the basis for planning and management of nature with introduction of the system of insurance in order to compensate the damage caused by the natural spontaneous phenomena, ecological and social factors of risk and the dynamic of diseases.

Thus, the prediction of the transition to «sustainable» development made by our macroeconomic model is very favorable for the Republic of Kazakhstan from the economic, ecological, and social point of view. In our model, it has shown that «sustainable development» not only leads to economic development of the country as a whole, but also provides higher GRP growth rates, smooth is unevenness in regional development, and promotes self-development - one of the main indicators of the country's well-being.

At the present stage of its development, the Republic of Kazakhstan has not yet reached this point of maximum on the ecological curve of Kuznets, which explains the degradation of the environment and the aggravation of the ecological situation and the subsequent increase in the incidence of the population of the regions of the Republic of Kazakhstan. One of the most disadvantaged regions in terms of environmental quality is the Karaganda region.

The transition to sustainable development and its management is a very long process, since it requires solving unprecedented social, economic and environmental tasks. As we move towards sustainable development, the very idea of it will change and be refined, people's needs will be rationalized in accordance with environmental constraints, and the means of meeting these needs will be improved. Therefore, the implementation of the principles of sustainable development should be considered in stages.

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Өнеркәсіптік және инновациялық даму контекстіндегі денсаулық тұрақтылығының мәселелері

Қазақстан Республикасы елдің әлеуметтік-экономикалық дамуында айтарлықтай экономикалық өсуге және елеулі нәтижелерге қолжеткізді. Алайда индустриялық-инновациялық дамудың, бизнес үшін «Жол картасы–2020» және басқалар үшін көшу бағдарламаларын іске асыру өндіріс пен тұтынудың дәстүрлі схемасы шеңберінде өңірлерге антропогендік қысымның бірнеше рет ұлғаюын, оның ішінде пайдалы қазбаларды, көмірсутекті, суды, жерді, энергетикалық ресурстарды, ластаушы заттардың шығарындылары мен көлемдерін ұлғайтуды, жаңа салалар мен инфрақұрылымдардың өсуін, олардың бірқелкі емес дамуын айқындауды және аумақтардың шөлейттену дәрежесін ұлғайтуды туындатады. Бүгінгі таңда Қазақстанда мемлекеттік экологиялық саясатты және орнықты дамуды басқару модельдерін әзірлеуге өзге де көзқарасты талап ететін бірқатар экологиялық проблемалар шешілмеген болып қалып отыр. Мақалада елдің орнықты дамуына кедергі келтіретін негізгі факторлар аталды: ресурстарды тиімсіз басқару; табиғи ресурстарды шамадан тыс тұтыну (антропогендік әсер ету); экономиканың тауарлық бағдары; аумақтардың шамадан тыс урбанизациясы; халық денсаулығы жай-күйінің нашарлауы; адам капиталы; өңірлік даму теңгерімсіздігі; экономикалық секторлардың төмен өнімділігі; өнеркәсіптік аймақтар санының ұлғаюы; су ресурстарының тапшылығы және аумақтардың шөлейттенуі; қоршаған ортаның ластануы; өндірістің энергия сыйымдылығы; жердің төмен түсімділігі және ауыл шаруашылығы дақылдарының түсімділігі және басқа да факторлар. Авторлар біз өңірдегі экологиялық проблемалар мен экологиялық жағдайды ескере отырып, халықтың денсаулығы сияқты факторды өңірлік аспектіде қарастырды. Сонымен қатар Қазақстан Республикасы өңірлерінің контекстінде тұрақты дамуды басқарудың экономикалық-математикалық моделін ұсынған.

Кілт сөздер: тұрақты даму, халық, денсаулық сақтау, экологиялық саясат, өңірлік аспект.

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Проблемы устойчивости здоровья в контексте промышленного и инновационного развития

Республика Казахстан добилась существенного экономического роста и значительных результатов в социально-экономическом развитии страны. Однако реализация программ перехода индустриально-инновационного развития, «Дорожной карты 2020» для бизнеса и других в рамках традиционной схемы производства и потребления вызывает многократное увеличение антропогенного давления на регионы, в том числе увеличение изъятий полезных ископаемых, углеводорода, воды, земли, энергетических ресурсов, выбросов и объемов загрязняющих веществ, рост новых отраслей и инфраструктур, определение их неравномерного развития и увеличение степени опустынивания территорий. На сегодняшний день в Казахстане остается нерешенным ряд экологических проблем, требующих иного подхода к разработке государственной экологической политики и моделей управления устойчивым развитием. В данной статье мы привели основные факторы, препятствующие устойчивому развитию страны: неэффективное управление ресурсами; чрезмерное потребление природных ресурсов (антропогенное воздействие); товарная ориентация экономики; чрезмерная урбанизация территорий; ухудшение состояния здоровья населения; человеческий капитал; дисбаланс регионального развития; низкая производительность экономических секторов; увеличение числа промышленных зон; дефицит водных ресурсов и опустынивание территорий; загрязнение окружающей среды; энергоемкость производства; низкая урожайность земель и сельскохозяйственных культур и другие факторы. В региональном аспекте рассмотрен такой фактор, как здоровье населения, с учетом экологических проблем и экологической ситуации в регионе. Авторами представлена экономико-математическая модель управления устойчивым развитием в контексте регионов Республики Казахстан.

Ключевые слова: устойчивое развитие, население, здравоохранение, экологический менеджмент, экологическая политика, региональный аспект.

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