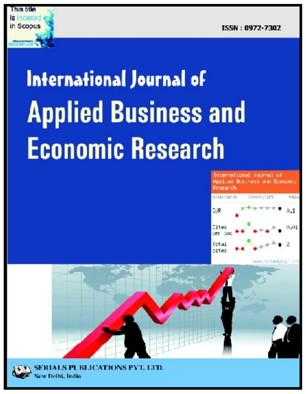

International Journal of Applied Business and Economic Research

ISSN : 0972-7302

available at http: www.serialsjournals.com

Volume 15 • Number 23 • 2017

Assessment of Ecologo-economic Health Population Risk

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Abstract: The article is devoted to the development of the paradigm of analysis and assessment of environmental and economic risks of public health as a central category of environmental security in the region. Modern research of this problem indicates a gradual displacement of environmental safety practices, based on the monitoring of maximum permissible emissions and discharges, and the promotion the system paradigm of management for ecological and economic risk, which is new for Russia. In this study, econometric and simulation tools are used to assess the risks for public health. The process of analyzing the environmental safety factors includes qualitative and quantitative assessment of natural and economic damage caused by environmental pollution. The authors carried out the analysis showed that the most appropriate approach to risk assessment is a method of calculating the cost of the health problems. This method is used for the transition from natural environmental damage to the system of econometric equations constructed according to the statistics of the Russian cities and districts of the Rostov Region for the years 2009-2014. Results of the analysis have allowed us to identify the factors most influential on the generalized evaluation of the incidence of pollutants in the atmosphere, the dependence of incidence on the quality of health care and living conditions, the level of per capita income. The results obtained will allow substantiating and correcting the priority areas of investment and economic policy in the region, taking into account the interests of health care and environmental protection.

Keywords: ecologo-economic risk, ecologo-economic safety, risk management, simulation modeling, public health

JEL Classification: J11, J13, J18

INTRODUCTION

In modern conditions of ecological-based management, a new type of activity is being formed - management of ecological and economic health risk from environmental pollution of the areas.

This problem is based on the specific terms, the leading ones are: environmental safety, environmental hazard, environmental threat, environmental risk factors. The concept of ecological security has been paid attention to in various studies (Golub & Strukova, 1995; Russkih, 2015; Smith & Krutilla, 1982; Tikhomirov, Potravny, & Tikhomirova, 2003). Based on the analysis and evaluation of common definitions we suggest the following wording of the environmental hazard: implemented or potential environmental threat as a result of anthropogenic or natural effects, causing human health deterioration or environmental degradation.

Analysis and evaluation of sources of environmental hazard and impact on the environment is also a popular area of research (Bloom, 1995; Cutter, 1994; Tikhomirov, Potravny, & Tikhomirova, 2003). The source of the impact on the environment can be determined as "a limited space to which all the characteristics of a specific impact on the environment can be attributed." Such a definition not only is useless but is hard to comprehend as well. It is therefore proposed to use the term "sources of environmental danger" - any form of human activity or natural phenomena in the field of worldwide, regional, local or site scale that cause (or are capable of causing under certain conditions) directional changes in the environment and violate human health.

The next term "environmental threat" has received a very vague definition when listing possible sources of threats (Colborn, Dumanoski, & Myers, 1996; Daily & Ehrlich, 1996). In fact, the definition of "environmental threat" has been blurred.

Another term that is often used in our field of research is "environmental risk factors» (Golub & Strukova, 1995; Lamb, 2002; Moldan, Billharz, & Matravers, 1997). Environmental risk factors (environmental threat) – are natural and anthropogenic impacts (disturbance) that can produce negative changes in the environment and human health. Thus, we can dwell on the following definition: environmental risk factors (environmental threat) are the components and initiators of the environmental hazard.

By 2000, a group of Russian researchers conducted preliminary studies assessing the damage to human health from air and water pollution (Bobylev *et al.,* 2004). Aggregate estimates were obtained for 1990-2000 and a forecast made for 2001-2010. However, the methodology used made it possible to obtain only very approximate results. By 2012, some attempts were also made to evaluate the damage to the health of the Russian population in the light of energy balance pattern change using EcoSense model developed together with the Institute for rational use of energy at the University of Stuttgart.

For Russian Federation, the scientific and practical experience in ecological and economic research gained in the European Union is of great interest. With the support of the European Commission several projects have been implemented in this sphere (GARP1, GARP2, TEPI), in which, in particular, the possibilities of holding the evaluation of environmental damage at the European Union's level caused by economic activities are evaluated (Jesinghaus, 2012). Damage assessment was presented as a percentage of GDP and included damage caused to human health, outdoor materials, productivity, forests and aesthetic features of the natural environment and ecosystems (Sakellariou & Patrinos, 1997). The most significant component of the overall ecological and economic damage - is damage to health (Jamison *et al.,* 2015).

The development of the methodology used in the European studies for assessing the environmental damage, in particular to health, is extremely promising for Russian Federation (Anopchenko *et al.*, 2015). Expert calculations have been made by authors on the basis of Russian data using the methodology approximated to the one used by European researchers. The preliminary and approximate assessment of the risks of water and air pollution suggests that health costs for the population, associated with pollution, are on average not less than 4-6% of the GDP (The Government of Rostov region, 2014). This highlights the need for adequate consideration of environmental factors in the plans and programs of the federal and regional level.

Among the problems connected with the use of European experience several should be noted, in particular, the complexity of the broader application of methods of subjective evaluation of "willingness to pay" or "willingness to accept compensation", the concept of "value of a statistical life", and others. (Colacci *et al.,* 2014). The level of poverty of the Russian population complicates their use and can give lower results. The widespread use of functions such as "dose-response" using data in developed countries should also be referred to as a difficulty (Andrews, 1985).

MATERIALS AND METHODS

Our research is based on an approach building on econometric modeling of damage to health as proposed by Tikhomirov et al. In this study the econometric models of morbidity were built on the basis of information reflecting the levels of morbidity and life conditions of the population in the regions of the Russian Federation for adult and children (under 15 years) population. The resulting patterns are presented in table 1.

Table 1
Economic dependence models of the morbidity of the Russian population from the factors characterizing living conditions

Territory / region	*Population category*	*Model equation*
Russian Federation as a whole, Moscow Region, Samara Region, Sverdlovsk Region, Chelyabinsk Region	adults	$y_B = b_{i1}\ e^{7.78}\ x_3^{-0.38}\ x_4^{-0.56}\ x_6^{-0.35}\ x_7^{-0.31}\ x_8^{0.28}$
	children	$y_D = b_{i2}\ e^{5.58}\ x_2^{-0.58}\ x_5^{-0.20}\ x_8^{-0.25}\ x_{10}^{0.26}$
Irkutsk Region, Krasnoyarsk Region, Murmansk Region, Tomsk Region, Chita Region	adults	$y_B = b_{i1}\ e^{1.5}\ x_2^{-0.2}\ x_6^{-0.7}\ x_{12}^{0.12}$
	children	$y_D = b_{i2}\ e^{1.6}\ x_2^{-0.3}\ x_6^{-0.5}\ x_{11}^{0.06}\ x_{12}^{0.12}$
Voronezh Region, Saratov Region, Rostov Region, Ulyanovsk Region	adults	$y_B = b_{i1}\ e^{-7.9}\ x_2^{-0.02}\ x_3^{-0.09}\ x_6^{-0.14}\ x_{10}^{-0.06}$
	children	$y_D = b_{i2}\ e^{-9.5}\ x_2^{-0.03}\ x_3^{-1.0}\ x_6^{-0.14}\ x_9^{0.12}\ x_{10}^{0.08}$
Kursk Region, Leningrad Region, Smolensk Region, Tver Region	adults	$y_B = b_{i1}\ e^{-0.19}\ x_2^{-0.06}\ x_3^{-0.21}\ x_9^{0.16}\ x_{10}^{0.12}$
	children	$y_D = b_{i2}\ e^{-2.7}\ x_2^{-0.02}\ x_3^{-0.25}\ x_9^{0.15}\ x_{10}^{0.09}$

On Table 1: x_1 – the annual retail turnover per capita (thousand rubles / person); x_2 – population security with physicians (unit / 10,000 people); x_3 – consumption of basic food products (meat, milk, eggs, potatoes, vegetables) per capita per year in terms of value (thousand rubles / person); x_4 – population security with places in stationary medical institutions (unit); x_5 – population security with female consultations, children's polyclinics, outpatient clinics (unit / 10,000 people); x_6 – population security with living space (square meters / person); x_7 – average summer temperature (°C); x_8 – forest resources (stock, square meters); x_9 – anthropogenic load on the atmosphere in the settlements of the region (index); x_{10} – anthropogenic load on the hydrosphere (index); x_{11} – the volume of emissions of pollutants into the atmosphere of the settlements (tce); x_{12} – the amount of pollutant discharges into the hydrosphere of the regions (tce); b_{i1}, b_{i2} – conversion factors of gravity and duration of the disease for adults and children in the *i-th* region respectively.

Analysis of the given wording of the concept of ecological and economic damage to health and the different approaches to the assessment leads to the conclusion of the common methodology and some of the differences in the valuation methods (Volkova, 2016). Thus, the development of a common methodology for assessing the environmental and economic health risk is of the objective need (Chopra & Kanji, 2011).

The major quantitative methods for determining the amount of damage to health from environmental pollution are (Cummings, Berube, & Lavelle, 2013):

1. Direct count method (reference, value-added area).
2. Methods of economic and mathematical modeling.

The direct count method is based on a comparison and analysis of parameters describing the negative effects of the natural environment on the recipients in the reference (value-added) region and in the contaminated area, i.e., direct costing and losses on expenditure and income items (Dixon & Hamilton, 1996). In practice, it is advisable to be used with a relatively small number of victims of environmental degradation (Michaels, 2014).

It follows that this method can only be used for determining the actual damage and can not be applied for the assessment of predicted damage. The most difficult in the application of this method is the correct selection of value-added (reference) area. It must meet the requirements that are partly mutually exclusive. Namely, it must match the analyzed region in all major natural, geographic and socio-economic parameters, with the exception of the level of environmental pollution. Thus, the reference and analyzed areas must be in similar climatic zones (for urban areas only area located in the urban zone can be a reference), have the same age composition of the population, etc.

In practice, the solution to this situation can be found in the search being performed on different reference areas by various damage components. For urban areas, when calculating the damage caused by environmental pollution, the assessment of damage to public health is a priority (Rybakov & Romanenko, 2014).

Based on this approach, the total amount of damage to health and living of persons at a given area in an amount of N prsons can be determined according to the following expression:

$$Y(N, \Delta S) = N\sum_{i=1}^{k}\left[n_i(\Delta S) - n_i\right]T_i ,$$

where $Y(N, \Delta S)$ - damage (loss of time, disability) of the population because of an increase in morbidity and mortality due to reduction of environmental quality by the amount ΔS;

$n_i(\Delta S)$ - the number of cases (deaths) *i*-th type, recorded at lower environmental quality (usually fixed per 10,000 inhabitants per year);

n_i - number of diseases (deaths) *i*-th type in the normal state of the environment;

T_i - the average duration of disease of the appropriate type;

k - number of considered types of diseases.

Simplistically, if $N = 1$:

$$Y(1, \Delta S) = \sum_{i=1}^{k} [n_i(\Delta S) - n_i] T_i \ .$$

It is easy to notice that the value of Y (1, ΔS), determines the average amount of time lost per person or 10,000 people (according to the specification of indicators $n_i(\Delta S)$ and n_i).

In practice, the values of $n_i(\Delta S)$ and n_i are usually defined for different age and gender groups (children, working-age population and pensioners). In this case, the value of $Y(N, \Delta S)$ is also calculated for these age groups separately, and then the overall damage is obtained by averaging based on their number.

Premature death is taken into account in this method as a type of disease with the appropriate amount of time wasted. The "specific weight" of death is usually great in man-caused accidents and natural disasters.

Many studies have indicated that during the disease humans maintain a relative ability to work and the number of days missed due to illness is not equivalent to the same number of days wasted due to death. This difference is typically offered to be taken into account by the introduction of a special factor reflecting the severity of disease as determined by the patient's condition. Death equals to 1, other diseases can be characterized by their severity, for example from 0.1 to 1.0.

In a number of scientific papers, some of the human conditions at the time of the disease are suggested to be "worse than death" with a severity factor greater than 1.0 (the patient is bedridden, experiences great suffering) (Daily & Ehrlich, 1996).

In view of such an amendment expression takes the following form:

$$Y(N, \Delta S) = N \sum_{i=1}^{k} [n_i(\Delta S) - n_i] q_i T_i \ ,$$

where q_i – is an indicator of the severity of the disease.

The most applicable in applied researches is a generalized indicator of morbidity in the city (district, region), calculated on the basis of medical statistics on the number of appeals to the medical institutions in one year and diagnosis on the basis of the following expression:

$$M_i = \frac{\sum_{r=1}^{R} T_r y_{ir}}{x_i} \ ,$$

where *Mi* - the generalized incidence rate in the i-th city / region;

Tr - the specific weight of the class of disease;

y_{ir} - the number of registered patients with r-th disease in the i-th city / region;

x_i - the population of the i-th city / region.

Significant difficulties in determining the quantitative characteristics of the indicator (4) relate to the values of the severity of various diseases. Generally speaking, for the purposes of this study the severity of the disease should be expressed as an average number of its duration. If the disease has led to the death, its duration could be expressed as a number of not lived years. However, in order to receive such assessments, it is necessary to process considerable data massifs in health care institutions as the medical statistics determines the average duration of the illness for a number of diseases incorrectly. The matter is that the duration of the disease in health care institutions is fixed according to the sick-list, i.e. according to the patient's address (number of cases). As a result, patients with complex and chronic diseases after a certain period of time are discharged, then address again, but each new address is considered as a separate disease.

It is more correct to express the severity of the disease on the basis of its fatal cases. However, it should be noted right away that in this case, it is difficult to attach "economic sense" to "the severity of the disease". For their definition, for example, it is possible to use the following expression:

$$T_r = \frac{D_r}{D},$$

where D_r – mortality due to the disease of the r-type,

D – mortality in the Rostov Region.

Thus, the expression (4) defines the indicator of an incidence of a certain city (district, region) which expresses the part of sick residents in the total population in the *i*-th city (district, region), taking into account the "weight" of a particular disease.

Econometric methods allow us to determine somewhat "optimal" equation based on the comparison and analysis of qualitative characteristics of some of its alternative options (Faleev, 2014). In particular, we believe that for the observable dependence the best results will be yielded by the exponential equation:

$$y_i = a_0 \prod_{j=1}^{n} x_{ij}^{a_{ij}} + e_{ij},$$

where a_{ij} – coefficients of influence of the factor x_{ij} on the dependent y_i variable.

In this connection, simple regressions based on cross-sectional data of some criterion of health when compared with the simultaneous quality indicators or environmental effects and other important variables are not fully adequate, particularly for measuring and predicting the amount of damage to health, not only for establishing of the association (Gerking & Dickie, 2013). This is due to several reasons:

1. Many economic, social and environmental processes are too complex to be represented by one equation connecting the dependent variable with a set of independent variables.
2. There may be multicollinearity between independent variables.
3. Regressions, being the reduced calculation form, cannot fully describe the true basic structure of the studied system.

Thus, we can draw a conclusion that in order to describe the investigated dependence it is necessary to have a set of two or more equations, in which independent or exogenous variables in some equations are actually endogenous to the system, i.e. they are dependent variables in other equations. However, the majority of empirical researches on the health damage from environmental pollutants did not consider the possibility of constructing a system of simultaneous equations for dependence research "damage to the health - pollution» (Sexton & Linder, 2014).

In modern scientific literature two basic approaches to the determination of economic assessments of damage to the health and life of the population were formed, each of which is divided into areas (Faleev, 2014):

– on the calculation basis of the cost of the disease;
– on the calculation basis of the cost of the disease time.

These approaches are based on quantitative assessments of health damage.

According to the first approach, the economic evaluation of health damage is determined by calculating the cost of the disease, which is also subdivided into direct and indirect. The direct costs usually include the cost of treatment, care and rehabilitation of the diseased, expenses on health protection events and social transfers (disability pensions, social security payments). The indirect cost represents the lost profit in production of GDP caused by human losses, i.e. disability due to illness and death.

According to the second approach the cost of the time of an illness is determined based on the concept of the human life value as such.

Depending on which items of expenditure are taken into account when determining the cost of an illness or which economic content is embedded in the concept of the "value of human life", in the context of the first and second approaches more specific assessment tendencies of the economic damage to health and life are emphasized.

For example, in some studies among the factors of health and human life damage it is proposed to distinguish the following: the loss of tariff and additional salary at the full-time and part-time job defined as the difference between the monthly systematic income and temporary disability allowance; the loss of the additional income from private subsidiary farming, entrepreneurship, contractor's agreements and other sources of unsystematic income; additional treatment costs, including the medicine and paid medical services expenses; additional food expenses which have limited consumption in everyday life; additional rehabilitation costs of the patient including sanatorium-resort therapy expenses, recovery in the recreation facilities, etc.; associated losses including family members' travel costs to shops, pharmacies, hospitals, etc., and also the family members' missed benefit; the losses connected with the need of professional retraining, change of the residence, premature retirement and so forth (Currie et al., 2015; Harrington & Elliott, 2015; Mittelmark, 2014; Myers *et al.,* 2013; Oleinik, 2002).

Thus, using the first approach, the damage valuation from the population morbidity due to the deterioration of environmental quality is determined on the basis of the following expression:

$$Y(N, \Delta S) = \sum_{i=1}^{k} r_i N_i (\Delta S) T_i \ ,$$

where $Y(N, \Delta S)$ – the magnitude of the damage caused by the higher sickness rate;

N_{ij} – additional in comparison with the background number of people diseased with the *i*-th illness;

r_{ij} – basic index of the health damage per person per day (RUR/person-day);

T_i – the average duration of the *i*-th dsease.

When using this method the damage has to be determined within the framework of similar socio-economic development of the regions which allows avoiding errors caused by social differentiation of the population (Ungar, Ghazinour, & Richter, 2013).

At the level of assessing the economic damage from the human health loss it is possible to find modifications above the considered approach to obtaining direct damage estimations from the morbidity based on the use of the concept "the quality of life" (Peckham, 2013). In general, this concept includes a wide range of physical and psychological factors which collectively characterize a person's ability to perform its inherent functions and to receive the appropriate satisfaction from it. One such factor is the state of health. In scientific literature the special term for quality of life reflection depending on the health condition is used – health-related quality of life (Runhaar *et al.,* 2010; Taylor & Hochuli, 2015).

For one's turn, the health condition is quantified as the "health index" on the basis of which values the life quality measurement leads to its reduction, i.e. time loss (years of life). The main problem in this case is to determine the lifetime of a given disease as a proportion of that time spent in a healthy condition. In this regard, the health level is usually represented as a point on the interval [0; 1], where "0" position reflects the "dead" state, and position "1" – "absolutely healthy".

At the same time the point position, in practice, is recommended to be determined by characteristics of the actual behavior of the person, and not by his clinical parameters (symptoms, signs, test results, etc.). Upon receipt of the quantitative values of the cost of living a number of alternative conceptual assumptions are used, among which are the following. The cost of the lost time is determined by:

1) the lost income amount;
2) the level of payment which the person is willing to make in order to avoid these losses (willingness to pay method);
3) the level of expenses in the public sector to ensure the normal activity during the considered period;
4) the "life insurance" method;
5) using the "time price" indicator and based on other methods.

Let us particularly consider the methods of determining the cost of the wasted time by the value of the lost income, adjusted by the level of consumer expenses and by willingness to pay for avoiding these losses.

According to the first of these methods, the value of losses due to the illness or death is defined as the current cost of the income loss minus the cost of consumer expenses, taking into account the probability to survive till next year. In turn, the accumulated value of the loss is defined as the discounted sum of current losses with a positive discount coefficient, when it comes to the reduction of future losses to the current time. In other words, future income has smaller value comparing with the current income. It is caused by the following:

1) income expected in the future is the subject to risk and is characterized by uncertainty;

2) future income growth will provide less economic welfare growth (the effect of marginal utility income reduction);

3) society prefers the present to the future (cherish the present more than the future).

The hypothesis of the existence of a certain sum, which a person is willing to pay for reducing the risk of death at some amount or, on the contrary, agrees to be the subject to the risk which is based on the assumption that under the normal circumstances he would organize his life so that to maximize their own utility function (the expected utility of their own life). Let us assume that this goal has been achieved, i.e. life utility for certain (known) values of the survival probability is maximized. That way the quantity of money that person is willing to sacrifice for the sake of increasing their own security is determined by the decrease of the probability of dying from the condition of invariance of the expected life utility.

Usually the utility function is formed on the basis of consumption indicators in the various years of human life. At the same time, entering the next period of the life, he possesses some certain information about its possible duration, i.e. knows the probability of the survival till the end of the considered period (year) p_t. From the moment of birth the product of such "annual" probabilities determines the probability of survival to the age of (t+1):

$$p_{t+1} = p_0 p_1 \cdots p_t \cdot$$

The increase in lifetime in each of its period is equivalent to increasing the survival probabilities in subsequent years, for which the person has to pay a certain amount (to reduce the life utility). Obviously, the usefulness of such increase depends on the age, the expected duration of remained life, the income, obligations to relatives and other factors.

Under certain simplifications for the person who has lived up to the age of t, it can be represented as the following function:

$$M[u_{T-t}(W_t)] = P_{T-t} L_{T-t}(W_t) + (1 - P_{T-t}) D(W_t),$$

where $M[u_{T-t}(W_t)]$ –expected utility in the time period T-t, depending on the level of available at the time of t goods (wealth) Wt;

P_{T-t} – the probability of living up to the age T, being in the age of t:

$$P_{T-t} = p_t p_{t+1} \cdots p_T \ ;$$

$L_{T-t}(W_t)$ – utility function of wealth on the period of T–t;

$D\,(W_t)$ – utility function in the event of the person death, if he dies during the period of T–t, its value can be regarded as zero, assuming that the remaining benefits are lost after the death of a person, or, as a positive value if their heirs can take advantage of these benefits.

If a person has the opportunity to reduce the death likelihood in the current period by the amount of Δp (to increase the probability of survival) by reducing the welfare by the V value, then the next ratio follows from the optimality condition of the utility function in the interval (T–t):

$$P_{T-t}L_{T-t}(W_t)+(1-P_{T-t})D(W_t)=(P_{T-t}+\Delta p)L_{T-t}(W_t-V)+(1-P_{T-t}-\Delta p)D(W_t-V).$$

Its semantic content is as follows: the usefulness of both life strategies is the same, but the first strategy is characterized by the high risk of death at big resources, and the second by the lower risk at smaller means. There is sort of an exchange of money for security. The proportions of an exchange depend on how much a person's live costs. This sum is also defined by a ratio of $V / \Delta p$.

DISCUSSION AND RESULTS

The results of the studies in 2014 in Russia showed that the assessment of the personal damage from illness per year is: loss of profits - $1000, "willingness to pay" method - $5.000, according to insurance tariffs and the "cost" of treatment - $600.

Comprehensive evaluation of population losses, defined as the sum of the cost of treatment and medical services, shortfall of gross domestic product, benefit payments and social insurance funds in Russia can be estimated at $3500 to $4000 accounting for approximately $10 a day per person.

It should be noted that similar estimates obtained for developed countries (USA, Austria, UK) just about to exceed those figures (The World Conservation Union & Unep, 2013). In particular, the assessed damages to health through "loss of earnings" adds up to $10.000 to $20.000 for "willingness to pay" $100.000 to $200.000 per year.

Thus, we can conclude that for purposes of this study the most applicable method is a quantitative method of economic and mathematical modeling, and for the economic evaluation - method based on the calculation of the cost of illness.

In 2014 the Administration of the Rostov Region, the environmental authorities, scientists, experts and significant organizational and practical work by the community, aimed at addressing environmental objectives and environmental safety, promoting the improvement of the ecological situation as well as health of the population in the region. Special attention was given to the implementation of measures to protect environment and natural resources, designed to improve their environmental situation in the region and ensuring the rational use of resources. In 2014 349.1 million rubles were allocated from regional budget for these purposes, along with 679.5 million Rubles for healthcare (The Government of Rostov region, 2015).

Overall mortality, as an important statistical characteristic of public health, has grown in 2014 in comparison with 2013 by 4,3% (in 2013 – 16,5 per 1000 population; 2014 – 16,9), which reflects the average in Russia. The growth rate was observed in 12 cities and 23 districts of the region. The decline was observed in two cities and 15 districts, mortality remained at the 2013 level in seven territories (The Government of Rostov region, 2015).

The calculation results of valuation of "natural" damage caused by pollution of the health of the environment are shown in table 2. From the presented data it is evident that overall amount of damages in the Rostov Region exceeds 438 million rubles per year. The highest economic damage to health from environmental pollution is produced in following cities: Rostov (130 million rubles), Volgodonsk (25 million rubles) and Novocherkassk (27 million rubles) and then following areas: Semikarakorskiy (9 million rubles), Aksaiskiy (8,7 million rubles), Oktyabrskiy (7,7 million rubles).

Table 2
Assessment of the economic damage to the public health of the cities and areas of Rostov Region, rub

Territory name	*Economic damage*	*Territory name*	*Economic damage*
	Cities of Rostov Region		
Rostov-on-Don	130 994 520	Kamensk-Shakhtinskiy	9 629 496
Azov	4 073 986	Krasniy Sulin	4 603 704
Bataysk	5 447 139	Millerovo	3 779 160
Belaya Kalitva	8 304 336	Novocherkassk	27 121 608
Volgodonsk	25 384 176	Novoshakhtinsk	17 315 424
Gukovo	7 254 024	Salsk	4 542 354
Donetsk	6 515 370	Taganrog	20 709 306
Zverevo	3 023 328	Shakhty	24 932 640
	Areas of Rostov Region		
Azovskiy	6 780 402	Milyutinskiy	871 611
Aksayskiy	8 706 792	Morozovskiy	3 415 968
Bagaevskiy	4 257 690	Myasnikovskiy	3 730 080
Belokalitvenskiy	2 804 922	Neklinovskiy	6 081 012
Bokovskiy	395 094	Oblivskiy	471 168
Verkhnedonskoy	1 208 940	Oktyabrskiy	7 744 824
Veselovskiy	3 901 860	Orlovskiy	3 069 954
Volgodonskiy	3 705 540	Peschanokopskiy	836 814
Dubovskiy	588 960	Proletarskiy	2 665 044
Yegorlykskiy	905 526	Remontnenskiy	525 156
Zavetinskiy	1 354 608	Rodionovo-Nesvetaysk	571 782
Zernogradskiy	4 881 006	Salskiy	7 273 656
Zimovnikovskiy	1 881 103	Semikarakorskiy	9 276 120
Kagalnitskiy	2 296 944	Sovetskiy	364 402
Kamenskiy	1 266 264	Tarasovskiy	797 550
Kasharskiy	2 009 826	Tacinskiy	4 230 696
Konstantinovskiy	898 164	Ust-Donetskiy	4 785 300
Krasnosulinskiy	2 554 614	Tselinskiy	3 592 656
Kuybyshevskiy	748 502	Tsimlyanskiy	3 514 128
Martynovskiy	5 948 496	Chertkovskiy	5 860 152
Matveyevokurganskiy	2 235 657	Sholokhovskiy	4 358 304
Millerovskiy	1 797 389	Total in the Rostov Region	438 795 248

The lowest rate of economic damage to health from the pollution lies in the following cities: Zverovo (3 million rubles), Millerovo (3.7 million rubles) and Azov (4 million rubles), and in following districts: Sovetskiy (364 thousand rubles), Bokovskiy (395 thousand rubles), Oblivskiy (471 thousand rubles). Thus, there is obviously a sharp differentiation between the levels of economic damage to the cities and districts of Rostov Region.

Studies in the area of cost assessments for environmental protection suggests that they can be characterized by capital investments in air protection and water resources which can be accounted for 80,5 million rubles and 114,5 million rubles respectively across the Rostov Region in 2014.

The expenses of providing the population with living space are determined from the calculation of its cost at $350 per square meter. Thus, on average it amounts to $7,000 per person (20 square meters per person), 40 billion dollars across the Rostov Region.

The economic factor scores obtained by calculation of the efficiency of social policies is given below:

$$F_D = \frac{438 \cdot 0,12}{679.5} = 0.077$$ (effectiveness of healthcare costs);

$$F_P = \frac{438 \cdot 0,14}{119000} = 0.000052$$ (effectiveness of housing increase);

$$F_V = \frac{438 \cdot 0,18}{80.5} = 0.98$$ (effectiveness of interventions in air protection);

$$F_W = \frac{438 \cdot 0,17}{114.5} = 0.615$$ (effectiveness of interventions in water resources conservation).

The derived figures are quite relative, but they make it possible to draw some conclusions. From the viewpoint of morbidity reduction the capital investments in air protection is the most efficient tendency of social policy.

In the protection of water resources in the cost of healthcare the effectiveness of investments are on the level, also noteworthy is the development of social policies to promote health across the population of the Rostov Region. We should mention that investments in nature conservation are effective not only in promotion of health, but also in preservation of environment and increasing the longevity of fixed assets and equipment. In this case we know that the effect from these investments is distributed to the population as a whole (in terms of reducing illnesses).

Increased level of housing availability would not be able to bring significant solution to this problem since the figures are rather high in the region as a whole.

Researches of the environmental pollution suggest that there is a need to develop an evaluation system of environmental and economic losses to the health of the public that aims to establish an objective picture of losses in a specific territory through environmental damages to the public health. Hence research aimed at clarifying links in the levels of illness in the population as an indicator of ecological and economic damage to the public health and environmental quality as well as socio-economic factors (cities and districts of the Rostov Region have been carried out in this study as an example).

Based on the analysis of the essence and structure of ecological and economic damage, key indicators of health as well as socio-economic and environmental factors have been identified determinant: living standards - indicators of per capita income retail sales and housing, level of medical care - an indicator of the number of doctors per 10 thousand people, the quality of the environment - emissions of pollutants into the atmosphere from stationary and mobile sources, as well as the volume of discharges of pollutants into the hydrosphere.

Selected indicators form the basis for the procedure of the research for dependency between health, environmental quality and socio-economic determinants, which allows to assess not only the losses in the “natural” and value terms, but also to determine the priority areas of socio-economic policies for strengthening public health.

It shows that in order to implement the proposed work procedure you must use the methods of econometric modeling, namely econometric equations.

The results of the analysis of the construction system of simultaneous equations showed that the greatest impact on the value of overall illness index are pollutant emissions in the atmosphere (increasing the pollutant emissions by 1%, general illness rate increased by 0,18%). Factors like availability of physicians and housing serve for reducing illness numbers (by increasing the parameters of availability of doctors or housing by 1%, overall illness rate decreased by 0,12% and 0,14% respectively). Increase in income per capita and availability of health care facilities enhances level of health services, acting as an essential factor in reducing illnesses (with an increase in per capita income by 1 thousand rubles and health care facilities by 1 per 10 thousand people, the number of doctors increased by 3,5 per 100 thousand people and 6 per 1 million people respectively). However, by increasing the proportion of illness cases by 0,01 average per capita income decreased by 5,1 thousand rubles.

The comparative analysis of valuation methods of “natural” ecological and economic damage caused by environmental pollution showed that the most appropriate method of such an assessment is a method of calculating the cost of the disease. This method was used for the transition from estimates of natural environmental damage to the economic estimates, according to which, in Rostov Region as a whole, the amount of damage exceeds 438 million rubles per year.

CONCLUSION

With limited material and financial resources, the effectiveness of social and economic policy directly depends on the priorities of the allocation of these resources on its directions. The result of the valuation of environmental and economic damage showed that in order to reduce the costs associated with the deterioration of public health, it is necessary to investigate the problem in terms of combining the interests of socio-economic policy.

The figures received from the calculation of the socio-economic policy effectiveness allow to draw the following conclusions.

In terms of reducing the morbidity the most effective direction of the social policy is capital investments in air protection. The effectiveness of investments in water conservation and health care also deserves attention when developing the directions of social policy for public health promotion. It should be noted that investments in nature conservation bring effect not only in health promotion but also in preservation of the habitat, increasing the service life of fixed assets and equipment. At the same time the effect from these investments is distributed among the entire population (in terms of reducing the morbidity). The increase in the level of housing provision can make a significant contribution to the solution of social and ecological problems only in case if this figure is at the rather low level in the region as a whole.

The results demonstrate that the complex system of measures aimed at supporting the public health and improving the environment quality in the territories and regions of Russia, and in particular in the Rostov Region, is required. This in turn demands a review of the investment policy for the benefit of public health and environmental protection (Parakhina, Boris, & Midler, 2015).

In conclusion we can say that the problem of assessing the ecologic and economic damage to the public health in the conditions of market economy is particularly significant since high-quality development of methods and methodology of this area of study will help to improve the environmental situation, and can act as a basis for the formation of the directions for more efficient environmental security policy in Russia and regions.

ACKNOWLEDGEMENT

We are grateful for the support (including financial) of the Administration of the Southern Federal University and to the scientific community of Faculty of Management of this University.

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