Middle-East Journal of Scientific Research 13 (Socio-Economic Sciences and Humanities): 108-114, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.13.sesh.1420

Analysis of the Impact of Environmental Stress on Social-and-Economic Well-Being of Population: Development of the Methodology and its Testing

Marat Rashitovich Safiullin, Leonid Alekseevich Elshin and Alina Ildarovna Shakirova

Center for Advanced Economic Research Academy of Sciences of the Republic of Tatarstan, Kazan, Russia

Abstract: This article displays the results of assessment of environmental and economic well-being of municipal territories of the Republic of Tatarstan. The authors developed a method to assess people's quality of life from the environmental load. The mathematical model of the impact of the environmental well-being in people's life expectancy, fertility and mortality. To analyze the effects of environmental conditions on the quality of life of individual administrative districts and regions of the Republic of Tatarstan, first we have assessed the level of individual well-being and environmental stress areas. In was based on the methodology of constructing composite indices. This resulted in the comprehensive indicators of habitat quality (KSO) and welfare (HPI). Was further developed by the authors calculated index IP. IP index shows the ratio between the level of welfare of the population and the level of environmental protection. We have introduced an innovative index to determine the so-called environmental "price" of the welfare of the population, this region provides a direct opportunity to develop a system of measures of state influence on the ecological environment in order to optimize the socio-economic development of the territory. Assessment tool developed by the well-being of the population on the environmental load of the region can highlight areas of particular risk (in terms of the environmental component) for which you want to develop measures to improve the environment and balanced socio-economic development.

Key words: Environmental and economic well-being · Modelling · Quality of life · Innovative index

INTRODUCTION

The problem consisting in estimation of influence exerted by ecological load on population well-being faced the scientific community in the most acute way in the 21st century. The problem of stable regional system improvement is conditioned by ecological difficulties of economic development and deterioration of labour-power reproduction conditions. This fact can be explained, in the first place, by growth of aggregate labour inputs into getting natural environment elements used in production; in the second place, social labour losses are observed as a result of misallocation of resources representing elements of natural environment; in the third place, there arises a necessity to allocate significant funds for liquidation of negative consequences of man-caused impact on natural environment. The existence of necessity to perfect a mechanism of economic, ecological and political decision-making with respect to development of infrastructure of regions with highly developed industry doesn't give rise to doubt. Under the existing economic conditions efficiency of such a mechanism is determined by the ability to coordinate/harmonize objectives of functioning and development of the two main links in the territorial-and-production complex – that is, the enterprise and region.

Economic-and-ecological programming becomes more and more important, as far as it has proved to play a role of an effective factor of economy's transition to sustainable development in many countries. Unfortunately, attention to economic-and-ecological programming weakened in our country during the years of economic reforms due to liberalism ideas domination.

It is important to note that the existing interregional distinctions affect economic development of the country as a common economic space.

There are a lot of works devoted to the problems of interregional inequality study, in which these matters are usually considered within the context of the following indices: the index of gross regional product (GRP) per

Corresponding Author: Marat Rashitovich Safiullin, Center for Advanced Economic Research Academy of Sciences of the Republic of Tatarstan, Kazan, Russia.

capita, life expectancy, unemployment level, poverty level and others [1]. However, inequality in life quality, which is determined by ecological characteristics of the territory, to a large degree and can be quantitatively measured with the help of ecological load indices, is the aspect of no less importance, as well. These factors become the prime cause of inequality by population health and migration indices. One more essential circumstance is also worth mentioning: habitat quality deterioration often lowers opportunities the regions have with respect to economy diversification. And namely for that reason we have set the following task – to estimate population well-being level within the context of ecological load experienced by territories.

To analyse influence that ecological situation exerts on life quality of population residing in separate administrative districts and regions of the Republic of Tatarstan, at first we individually estimated the level of population well-being and ecological load experienced by territories. As a result we obtained integral indices of habitat quality (KSO) and population well-being (PWBI) [2].

In this connection it is offered to introduce a new index demonstrating correlation between IBN and KSO. The IP index plays the role of such an index. The IP index demonstrates correlation between the population well-being level and ecological environment development level IP = IBN/KSO. Lower IP index value is the evidence of a higher well-being level with respect to the level of ecological load experienced by the territory analysed. This relative indicator shows the degree of influence of ecological pollution of a certain territory, in other words: which level of population well-being compensates ecological load. The higher is IP index value, the more positive the situation in the region is.

Final aim of any progressive society development is creation of favourable conditions for long, healthy life of people, being problem-free in financial respect. Analysis of trends observed in changes in level and quality of life of the population permits to judge how efficiently the society manages to cope with this task.

Problems of scientific research into a complex of characteristics describing quality of life and health of population occupy a significant place in the present-day world. The latter fact is connected, in the first place, with a situation of a systems crisis formed in the domestic economy, as well as with lowering of living standards, experienced by the major part of the population of our country. In this connection the problems of theoretical understanding and practical implementation of questions relating to complex assessment of life quality, health and well-being of population together with studying of factors forming and changing them under the transient economy conditions become especially urgent.

A whole complex of factors exerts influence on life quality and well-being of population of any region to this or that extent. The most important place among the abovementioned factors is occupied by social-and-economic and ecological, as well as institutional and medical-and-demographical factors, including various characteristics of financial welfare and health of the people and quality of surrounding natural environment [3].

Within the last three decades growth of interest in the problem of life quality has been connected with the fact that the society has realized global problems of modern times, as well as with requirements of international standards and European Union countries, established with respect to social-and-economic status optimization and economic potential modernization on the basis of innovation technologies and also with Russia striving for becoming a full WTO member.

The necessity to quantitatively assess quality of life has arisen under the aforementioned conditions, with such an assessment permitting to obtain data about diverse living conditions of society members. However, the obtained data are not always able to become a basis for life quality management and various methodological approaches to its quantitative assessment are pretty often used in different regions. In order to eliminate this shortcoming and obtain reliable comparable parametric values, the authors have introduced a new term, which hasn't been used before, along with its determination model, that is: "Population Well-Being Index".

Population Well-Being Index, in the authors' judgement, is a set of characteristics reflecting: favourable social-and-economic conditions; degree of the needs and interests system satisfaction for optimal life of individuals and separate social groups; state of health; quality of ecological system's components as a whole, with such quality ensuring that: various factors (social-and-economic, ecological, institutional, biological, chemical, physical etc.) have no detrimental effect on health of the people, favourable conditions are provided for their vital activity and opportunities for further development of human potential of the present-day and future generations and sustainable society development exist.

Population Well-Being Index is included in the family of the notions of way, style, level, quality and cost of life of the people, which are close, but still not identical to it

by content. Having features similar to that of the above mentioned notions, the offered Index is characterized by the following parameters as its main distinguishing features: public health index, representing systematizing factors of well-being and the most important value of human life; institutional peculiarities, ensuring optimal functioning of all spheres of human life; state of surrounding natural and artificial habitat, in which various factors have no detrimental effect and favourable and safe vital activity conditions are finally provided for population residing on the given territory.

Thus, there can be three aspects forming well-being of the population distinguished:

- satisfaction of needs of the population (main group): labour, material, family, spiritual needs;
- activity categories – main spheres of human activity: labour, daily chores, rest;
- living conditions, including characteristics of social environment, surrounding natural habitat conditions and conditions of surrounding artificial (second nature) habitat created by the man.

To identify interrelations between these characteristics and estimate population well-being indices the authors have set the tasks to: pick out criteria describing problem-free residence of the people on the territory, calculate an integral index – the Population Well-Being Index and perform econometric modelling of influence exerted by ecological factors on the offered Index.

To solve the problem consisting in determination of quantitatively measurable indicative indices of the population well-being, the authors, being based on integrated multivariate study, have picked out several blocks of factors, exerting the strongest influence on the level of well-being of the population residing on the given territory, namely [4]:

- Public health criteria.
- Living standard.
- Social sphere.
- Consumer market of goods and services.
- Labour sphere.
- Population housing rate.
- Rate of transport and communication facilities provision for the population.

To quantitatively evaluate the population well-being by each block of factors we have determined indicative indices on the basis of the conducted research. Selection of criteria, required to form an integral factor (index) of the population well-being, has been made from the available statistical data base [5, 6]. The system of indices doesn't contain expert indices or indices based on public inquiry results.

Public Health Criteria:

- Life expectancy, years;
- Natality rate per 1000 inhabitants;
- Mortality rate per 1000 inhabitants;
- Infant mortality rate per 1000 children born alive.
- Living standard:
- Average monthly wage assigned to employees working in the sphere of economics, rub.;
- Average per capita cash incomes to minimum of subsistence ratio, %.

Social Sphere:

- Provision of children aged 1 to 6 with places in pre-school institutions, places per 1000 children.
- Quantity of schoolchildren per one teacher in municipal institutions of general education, men.
- Specific share of full-time schoolchildren studying in state institutions of general education, who study in the second shift, as of the beginning of the academic year 2010/2011, % (negative index).
- Specific share of students who have passed the Uniform State Examination (EGE) in the quantity of school-leavers of municipal institutions of general education, who have taken the unified state examination, %.
- Quantity of hospital beds per 10 000 inhabitants.
- Quantity of doctors per 10 000 inhabitants. 18. Paramedical personnel strength per 10 000 inhabitants.
- Paramedical personnel strength in municipal health-care institutions per 1 doctor on the average, men.
- Quantity of places in cultural and leisure-time entertainment institutions per 1000 inhabitants.
- Quantity of books available in public libraries per 1000 inhabitants, thousand copies.

Consumer Market of Goods and Services:

- Retail trade turnover per capita, rub.
- Volume of paid services per 1 inhabitant.
- Labour sphere:

- Quantity of small- and medium-scale business entities per 10 000 inhabitants, pieces.
- Level of registered unemployment, % of economically active population (negative index).

Population Housing Rate:

- Dwelling house introduction into service, sq.m.
- Average housing rate, sq.m. of total floor space per 1 inhabitant.

Rate of Transport and Communication Facilities Provision for Population:

- Rate of the population provision with automobiles in private ownership per 1000 inhabitants, pieces.
- Rate of the population provision with cellular phones and Internet-communication per 100 families, pieces.

Some of the abovementioned indicative indices are both of quantitative and quantitative-and-qualitative nature. They characterise some social aspects of the Russian economy development in a qualitative respect.

To solve the first task, consisting in comparison of the listed social-and-economic indices, included in calculation of the Population Well-Being Index determined for population residing on the territory of municipal entities, we offer to apply empirical approach, which is based on the index method of unification of indices having different dimensionality [7], well-known in statistics. This method permits to calculate an integral index – "Population Well-Being Index". This Index can be used both for paired and multiple comparisons.

To get point ratings a range scale of real values is drawn up by each of the indices determined for all the regions. Ranges are determined on the basis of minimum and maximum values of this index. After that the ranges are divided into 100 equal intervals (with the view of a more detailed data analysis), where each interval corresponds to a certain quantity of points, equal to the interval number (from the 1st to the 100th). And namely the point rating sum, determined by all the indices of this region and derived in compliance with the 100-point calibration scale, represents the "Population Well-Being Index". Indices can be drawn up by separate groups or sets of indices in order to more accurately evaluate individual aspects describing the state of affairs in the region (depending on the nature of research these or that indices, having the greatest significance in these cases, can be assigned multiplying weighting coefficients) [8].

Table 1: Population Well-Being Index Evaluation

Characteristic of the Population Well-Being Index	Point sum
High (optimal)	71 and higher
Satisfactory	51 – 70
Insufficient	31 – 50
Low (arousing anxiety)	less than 30

In such a way, the Population Well-Being Index (PWBI), determined for this or that district as an index characterizing the level of well-being of the population residing in the given district, will be characterized by a sum of point rating values determined for indices chosen by us [9]:

$$I_R = \sum_{i=1}^{N} P_i, \quad (1)$$

where

I = Index;

N = Number of indices in a set;

P_i = Point rating, corresponding to a value of the i-th index.

Thus, the Population Well-Being Index has been calculated in a step-by-step mode, which permitted us to rank municipal entities of the Republic of Tatarstan by the degree of problem-free residence on this territory.

Population well-being level has been estimated with the help of a scale given in Table 1.

To analyse the dynamic influence of ecological environment on quality of life of population residing in separate administrative districts and regions, as well as to analyse efficiency of work performed by administrations, governmental bodies and local self-government bodies, one has to fulfill the 2nd task of the research: calculation of an integral index of habitat quality (KSO).

The integral index of habitat quality (KSO) is measured in points and represents a design index. Its calculation is based on points-factor evaluation method. According to this method, indices of air, water and soil quality having different dimensionality are converted to points. Such a conversion permitted to get generalized parameters by an aggregate of indices characterizing the degree of ecological well-being in the Republic of Tatarstan.

Components of ecological system existing in municipal districts of the Republic of Tatarstan have been got by means of data averaging by habitat risk factors taken for the year of 2009. In such a way, "integral index of habitat quality" is a complex index, taking into account ecological load experienced by population residing on

the given territory, which consists of pooled points-factor estimate of influence exerted by components of: air and water resources quality, land resources condition, vegetable world condition and condition of waste products and consumption residues handling system.

There have been the following factors chosen as indices estimating habitat quality:

- Volume of hazardous (polluting) substance emissions into the atmospheric air from stationary sources located on the territory of a municipal entity, thousand tons.
- Share of used, neutralized waste in total volume of waste formed in the process of production and consumption in the municipal entity, shares (Used is an index of waste formed in the process of production and consumption in the municipal entity, with the deduction of used and neutralized waste, thousand tons).
- Volume of hazardous (polluting) substance emissions into the atmospheric air from automobile transport registered on the territory of a municipal entity, thousand tons.
- Volume of polluting substance emissions from stationary sources per capita, kg/man (negative index).
- Share of polluted (untreated) waste waters in the total water disposal volume in the municipal entity, %.
- Drinking water quality by sanitary-and-chemical and microbiological indices: specific share of special tests by sanitary-and-chemical indices.
- Polluted waste waters discharge into surface objects, mln. cubic metres (negative index).
- Share of disturbed lands in the municipal entity, %.
- Share of collected and neutralized emissions of polluting substances in total quantity of polluting substances drawn off from all stationary sources located on the territory of the municipal entity, %.
- Share of collected secondary material resources in total volume of formed solid household and industrial waste, %.

The index "Share of collected and neutralized emissions of polluting substances in total quantity of polluting substances drawn off from all stationary sources located on the territory of the municipal entity, %" was taken into consideration when calculating values of the index "Volume of hazardous (polluting) substance emissions into the atmospheric air from stationary sources located on the territory of a municipal entity". In a similar way, used waste recording implies partial inclusion of secondary waste. That is why, to avoid double counting, 3 factors haven't been picked out as independent ones for calculation of a consolidated index of habitat quality, but they have directly affected the result [10].

Table 2: Habitat Quality Index Evaluation

Characteristic of the Habitat Quality Index	Point sum
High (optimal)	0 – 20
Satisfactory	20 – 50
Insufficient	50 – 100
Low (arousing anxiety)	100 and higher

The procedure of determination of the consolidated index reflecting habitat quality is analogous to the previously described approach to identification of the Consolidated Population Well-Being Index. The primary statistical data used for calculation are given in Appendix 1.

Calculation of the consolidated index of habitat quality has been made with the help of a specially developed software product.

Level of ecological well-being of the population is estimated with the help of a scale given in Table 2.

Simulation of the system of interaction between ecological environment and population well-being level has demonstrated direct relation between the factors considered. A population well-being level determined for the respective municipal district or city is higher in those areas where ecological environment level has maximum negative index values. In this connection a multi-factor model determining relation between IBN and ecological parameters displays a direct relation. This fact doesn't permit to develop a system of governmental influence on ecological environment in the Republic of Tatarstan.

In this connection it is offered to introduce a new index demonstrating correlation between IBN and KSO. The IP index plays the role of such an index. The IP index demonstrates correlation between the population well-being level and ecological environment development level IP = IBN/KSO. Lower IP index value is the evidence of a higher degree of well-being level dependence on ecological environment level. The higher is ecological pollution level value, the lower is IP index value.

A set of independent factors involved in IP model has comprised only those factors which produce adverse effect on habitat quality, so as to ensure an in-depth analysis of negative influence produced on relative well-being of population by ecology.

Table 3: Index IP

Index Characteristic	Point Total
High (sufficient)	23 and higher
Satisfactory	10 to 23
Insufficient	7 to 10
Low (arousing anxiety)	Less than 7

IP = 21,9 – 0,175* Factor_3 – 0,027* Factor_4 – 0,204* Factor_5 – 0,281* Factor_6

For instance, in spite of high values of life quality, income level and social-and-economic development indices in whole, the IP value for Kazan makes 2,03 points, while for Baltasinskiy district IP = 12,9 points. Therefrom one can draw the following conclusion: large value of ecological pollution level significantly reduces return on funds and efforts invested in the district development and consequently it is necessary, above all, to exert influence upon those territories of the Republic of Tatarstan, in which IP index has the lowest values. Decrease in KSO level will permit to increase IP level for this or that municipal district, provided that the population well-being index remains invariable.

The hypothesis of necessity to determine the level of ecological influence on ecological potential return index of the territory (IP) has been taken as a basis for a new multi-factor model. At the same time, this model permits to establish the degree of influence that the respective factor characterizing ecological situation exerts on IP. Such an advantage of the described method determines the direct opportunity to develop a system of measures of governmental influence on ecological environment with the purpose of IP optimization (Table 3).

The considered approach permits to group municipal districts of the Republic of Tatarstan by the degree of optimal or, oppositely, nonoptimal correlation between the population well-being index and ecological pollution index. And namely in those areas where this ratio (IP index) has minimal value one has to exert influence upon ecological situation, in the first place. At the same time, the degree of such influence will be determined on the basis of a model establishing interaction between the IP index and ecological factors.

The essence of the IP-index can be graphically depicted by means of drawing a bubble diagram, reflecting the KSO value along the x-axis for municipal entities and IBN values – along the y-axis. As we can see, the area formed in the coordinate system can be divided into 4 conditional quadrants, characterizing different degrees of a favourable social-and-economic development of the population under the existing ecological load conditions. It's obvious that regions located in the I quadrant are in the best state, because, in addition to a high development level typical to it, it is also the leader by ecological situation indices (KSO point value is lower than an average point value). In contrast to the I quadrant, regions being in the worst state both in social-and-economic sphere and in the ecological situation aspect are concentrated within the bounds of the IV quadrant (for example, Sabinskiy district). Regions characterized by sustainable development were depicted in the II and III quadrants (above the diagonal line, plotted with red colour) (and besides, the farther the region is from the origin of coordinates, the higher is social-and-economic development rate). Special attention should be paid to regions located in these quadrants, but below the diagonal line. In our opinion, a plan of measures, which will permit to improve ecological conditions and stabilize the existing situation, should be developed namely in these regions. It is so because real ecological indices characterizing the above indicated regions are not justified by the current population well-being level.

In this way, the developed toolset, destined to estimate population well-being relative to ecological load experienced by the given region, permits to pick out special risk zones (from the point of view of the ecological component), for which one should develop measures on ambient environment condition improvement and balanced social-and-economic development provision.

REFERENCES

1. Safiullin, M.R., L.A. Elshin and A.I. Shakirova, 2012. Assessment of business and economic activity as a tool for short-term forecasting. Herald of the Russian Academy of Sciences, 7: 623-627.
2. Nagimova, A.M., 2010. Problems of measurement and interpretation of quality living area, Regionologiya, 3: 183-188.
3. Kundakchan, R.M., 2007. Influence of environmental and economic factors on the quality of life. Kazan University Press, pp: 125.
4. Scott, N.W. and M.F. Peter, The relationship between overall quality of life and its subdimensions was influenced by culture: analysis of an international database. Journal of Clinical Epidemiology, 61(8): 788-795.
5. Ferrans, C. and M. Powers, 1985. Quality of life index: Development and psychometric properties. Advances in Nursing Science, 8: 15-24.

6. Axyanova, A.V., A.A. Shakirova and L.A. Elshin, 2011. Assessment of business activity in the region with application of the summary advancing index. Herald Kazan Technological University, 8: 263-268.
7. Renwick, R. and D. Raphael, 2002. The quality of life profile: a generic measure of health and well-being. Quality of Life Research Unit. Department of Occupational Therapy. Centre for Function and Well-Being. University of Toronto. Toronto, ON, Canada http://www.utoronto.ca/qol/profile/adult Version.html.
8. Sirgy, M.J., A.C. Michalos, A.L. Ferriss, R.A. Easterlin, D. Patrick and W. Pavot, 2006. The Quality of Life (QOL) research movement: past, present and future. Social Indicators Research, 76: 343-466.
9. Chisholm, D. and D. Bhugra, 1997. Sociocultural and economic aspects of quality of life measurement Original Research Article. European Psychiatry, 12(4): 210-215.
10. Irene van Kamp, Kees Leidelmeijer, Gooitske Marsman and Augustinus de Hollander, 2003. Urban environmental quality and human well-being: Towards a conceptual framework and demarcation of concepts; a literature study. Landscape and Urban Planning, 65(1-2): 5-18.