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METHODOLOGY OF ECOLOGICAL AND SOCIAL EVALUATION OF UKRAINIAN RURAL SETTLEMENTS TERRITORIES

I.M. Pustovit, post graduate student*

The methodology was worked out for determination of ecological and social condition of Ukrainian territories of rural settlements according to the main criteria (conditions of land use, soil quality, radiological and toxicological, sanitary and hygienic, demographic, infrastructure and social and economic data) for evaluation of their development.

Key words: eco-social evaluation, territories of rural settlements, ecological criteria, social criteria, environment, sustainable development.

Rural area is a complex and multifunctional natural, social and economical, production and commercial structure that is characterized by the land area, number of inhabitants and workers engaged in production and service facilities, production volumes and structure, development of social and production infrastructure and other characteristics[1]. During a long period of time of extensive management the majority of Ukrainian lands appeared in a crisis and catastrophic situation caused by unallowable agronomy (71.3% of agricultural land), oversaturation of field seeds rotation by tilled crops, decrease of ecologically stable lands (forests, meadows and pasture grounds), pollution of the territories [2]. Ecological problems of big cities are being studied by scientists for a long time (domestic and utility waste utilization, transport pollution, urbanization [3-6], etc.) but environmental problems of rural areas are studied not good enough. Social and ecological factors are the criteria of human activity that positively or negatively influence on both environmental situation and human beings [7].

The literature has a considerable amount of methodological approaches of separate estimation of ecological and social environment [8-11]. There is a number of both

* **Supervisor - Doctor of Medical Science, Professor V.A. Prylypko.**

individual and complex indexes but there is no single system and exact correspondence with current regulatory documents.

Therefore the main task is to determine the list of characteristics for adequate estimation. The system of such characteristics should be considered taking into account the possibility to use the information of acting control services and the necessity to increase researches on the basis of modern technical base and prospective methods [12].

On the 30th of October 2001 the Convention about information access, participation of community in the process of making decisions and access to justice in the environmental questions came into effect. According to the Convention adequate protection of environment is important for wellbeing of humans, each person has the right to live in favorable living environment and has the obligation to protect and improve environment both in individual and common way for the benefit of present and future generations, to spread ecological knowledge for better understanding of environmental processes and stable development and encourage public information about decisions regarding environment and stable development and its participation in making such decisions stressing the importance of mass media, electronic and other means of future communication as well as that state organs own ecological information for the benefit of community [13]. Therefore creation of evaluation ecological and social passport is an important step for information about situation in rural settlements of Ukraine.

Determination of environmental and living quality has be based on integral indexes. Integral index includes all characteristics that can influence the above mentioned quality this or that way.

The research purpose – scientific and methodological grounding for estimation of rural settlements area and their ecological and social criteria and evaluation of their development.

Materials and methods of research – complex approach of social and ecological evaluation of Ukrainian rural settlements area supposes parallel appliance

of several data analyze methods in order to receive objective estimation results depending on separate research tasks. Thus in order to estimate social and ecological situation of rural settlements it is rational to use statistical data of the following institutions and administrations: sanitary and epidemic service, state project and technological soil capabilities and products quality protection center “Oblderzhrodyuchist’”, village councils, village agricultural enterprises, and compare the results with the data of scientific analysis and social and economical statistics. The latest regulatory documents and methodological recommendations of state administrations and institutions of Ukraine were used for creation of evaluation passport. Analytical and mathematical methods were applied during the research.

Results of the researches and their consideration. On the basis of received data and indexes that allow to estimate separate ecological and social factors of rural areas we have grounded the criteria for estimation of rural settlements territories and their development: conditions of land use, soil quality, radiological and toxicological, sanitary and hygienic, demographic, infrastructure and social and economic condition.

The main demands to selected indexes were availability and accessibility of information in state institutions or administrations, informational content of indexes and their changes within years, correspondence with state regulatory documents (DSTU (Ukrainian national standardization system), Ukrainian national construction regulations, sanitary regulations and standards, etc). Five-point grading scale was used for estimation as traditional one. The levels of ecological and social development are as follows: 1 – very unsatisfactory; 2 – unsatisfactory; 3 – satisfactory; 4 – good; 5 – excellent. The priority order for lands condition improving is according to the scale.

Regulatory values for calculation of each ecological index are shown in the Table 1.

The selected data are estimated according to the Table 1 (for example: overtilled agricultural lands - 47% corresponds with the mark 3 – satisfactory

ecological situation (other marks for each ecological and social index are determined analogically). The integral ecological index is calculated by the formula 1 using the determined marks. Previously the integral indexes of each criterion are to be calculated (formulae 2-5).

The integral ecological index (IEI) is calculated by the formula:

$$\mathbf{IEI} = \frac{\mathbf{Ilu} + \mathbf{Isq} + \mathbf{Irt} + \mathbf{Ish}}{\mathbf{4}}, \quad (1)$$

Ilu, Isq, Irt and Ish are the integral indexes of each ecological criterion determined by estimation indexes; 4 – is the number of criteria.

The integral index of land use is determined by the formula:

$$\mathbf{Ilu} = \frac{1}{2} \sum_{i=1}^2 \mathbf{LU}_i, \quad (2)$$

Here 2 – is the number of indexes that characterize land use conditions, \mathbf{LU}_i is the value of i index of land use.

Integral index of soil quality is determined according to the formula:

$$\mathbf{Isq} = \frac{1}{6} \sum_{i=1}^6 \mathbf{SQ}_i, \quad (3)$$

Here 6 is for number of indexes of soil quality, \mathbf{SQ}_i is for value of i index of soil quality.

Integral radiological and toxicological index is determined by the formula:

$$\mathbf{Irt} = \frac{1}{6} \sum_{i=1}^6 \mathbf{RT}_i, \quad (4)$$

Here 6 is for number of indexes of radiological and toxicological territory features, \mathbf{RT}_i is for value of i index of radiological and toxicological characteristic.

$$\mathbf{Ish} = \frac{1}{8} \sum_{i=1}^8 \mathbf{SH}_i, \quad (5)$$

In this formula 8 is for number of indexes of sanitary and hygienic features of the territory, \mathbf{SH}_i is for value of i index of sanitary and hygienic characteristic.

1. Table for rural settlements ecological situation determination for ecological criteria

#	Indexes	Regulatory values				
1.	Conditions of land use					
1.1	Forest cover, %	<16,0	16,1-22,0	22,1-24,0	24,1-36,0	>36,0
1.2	Overtilled agricultural lands, %	> 60,0	50,0-60,0	45,0-50,0	40,0-45,0	<40,0
2.	Soil quality					
2.1	Humus content, %	<1,1	1,1-2,0	2,1-3,0	3,1-4,0	>4,0
2.2	N content according to Cornfield, mg/kg	<100	100	101-150	151-200	>200
2.3	P content according to Kirsanov, mg/kg	<50	51-100	101-150	151-250	>250
2.4	K content according to Kirsanov, mg/kg	<80	81-120	121-170	171-250	>250
2.5	Water index of soil solution	4,1-4,5	4,6-5,0	5,1-5,5	5,6-6,0	6,1-7,0
2.6	Bonitet mark	21-30	31-40	41-50	51-60	>60
2.7	Organics usage, t/ha	<0,5	0,5-1,5	1,5-2,5	2,5-3,5	>3,5
3.	Radiological and toxicological					
3.1	¹³⁷ Cs content, Cu/km ²	>15,0	10,0-15,0	5,0--10,0	1,0-5,0	<1,0
3.2	⁹⁰ Sr content, Cu/km ²	>3,0	0,15-3,0	0,08-0,15	0,02-0,08	<0,02
3.3	In stock pesticides and agricultural chemicals class	I	II	III	IV	
3.4	Cd soil pollution, f. mg/kg	>6,0	6,0	3,0-5,9	0,5-3,0	<0,5
3.5	Pb soil pollution, f. mg/kg	>64,0	64,0	32,0-63,9	10,0-32,0	<10,0
3.6	Hg soil pollution, f. mg/kg	>4,2	4,2	2,1-4,19	0,02-2,1'	<0,02

Table 1, proceeding

#	Indexes	Regulatory values				
4.	Sanitary and hygienic					
4.1	N-NO ₃ content in centralized water supply, mg/dm ³	>50,0	10,0-50,0	7,1-10,0	5,0-7,0	<5,0
4.2	Fe ²⁺ content in centralized water supply, mg/dm ³	>2,0	1,0-2,0	0,3-1,0	0,2-0,3	<0,2
4.3	Water pH level in central water supply	>8,5	6,0-8,5	6,0-8,0	6,5-8,5	6,5-7,0
4.4	N-NO ₃ content in decentralized water supply, mg/dm ³	>50,0	10,0-50,0	7,1-10,0	5,0-7,0	<5,0
4.5	Fe ²⁺ content in decentralized water supply, mg/dm ³	>2,0	1,0-2,0	0,3-1,0	0,2-0,3	<0,2
4.6	pH level in decentralized water supply	>8,5	6,0-8,5	6,0-8,0	6,5-8,5	6,5-7,0
4.7	Class of air pollution enterprise	I	II	III	IV	V or abcent
4.8	Correspondence of solid domestic waste range to the regulations	1/5 or abcent	2/5	3/5	4/5	5/5
Rural settlement ecological situation		1	2	3	4	5
		Very unsatisfactory	Unsatisfactory	Satisfactory	Good	Excellent

Regulatory values that will be used for estimation calculation of social index are shown in the Table 2.

Integral social index (ISI) is determined by the formula:

$$ISI = \frac{Id + Ii + Ise}{3}, \quad (6)$$

Id, Ii, Ise are for integral indexes for each social criterion determined by the estimation values and 3 is for number of social criteria.

Integral demographical index is determined by the formula:

$$Idm = \frac{1}{5} \sum_{i=1}^5 Di, \quad (7)$$

Here 5 is for number of indexes that characterize demographical situation in rural settlement and D_i is for value of i index of land use conditions.

Integral infrastructure index is calculated according to the formula:

$$Ii = \frac{1}{6} \sum_{i=1}^6 Ii, \quad (8)$$

Here 6 is for number of indexes that characterize infrastructure development in rural settlement and I_i is for value of i index of infrastructure characteristics.

Integral social and economical index is determined the following way:

$$Ise = \frac{1}{3} \sum_{i=1}^3 SEi, \quad (9)$$

3 is for number of indexes that characterize social and economic situation in rural settlement and SE_i is for value of i index of social and economic characteristic.

General integral ecological and social index (GIESI) of rural settlement territories of Central Polissya region of Ukraine is calculated by the formula:

$$GIESI = \sqrt{IEI \times ISI}, \quad (10)$$

Table 2 for rural settlement social situation determination Social criteria

#	Indexes	Regulatory values				
1.	Demographical					
1.1	Annual population, persons	50-200	200-500	500-1000	1000-3000	3000-5000
1.2	Birth rate, ‰	<8,5	8,5-9,5	9,5-10,5	10,5-11,5	>11,5
1.3	Death rate, ‰	> 15,99	14,99-15,98	14,21-14,98	13,35-14,20	< 13,34
1.4	Natural increase, ‰	<-11,0	-10,0-(-11,0)	-9,0-(-10,0)	- 8,0- (-9,0)	>-8,0
1.5	Demographical old age level, d ₆₀₊ , %	>14,0	12,0-14,0	10,0-12,0	8,0-10,0	<8,0
2.	Infrastructure					
2.1	Village council, school, preschool institution, medical institution, church	1/5	2/5	3/5	4/5	5/5
2.2	Telecommunication department, market services, bath-house, food services, cultural centre	1/5	2/5	3/5	4/5	5/5
2.3	Gasification, %	0	1,0-30,0	31,0-60,0	61,0-90,0	>91,0
2.4	Centralized water supply, %	0	1,0-30,0	31,0-60,0	61,0-90,0	>91,0
2.5	Transport support, marks	0	1	2	3	≥4
2.6	Distance to regional center, km	> 40,0	30,0-40,0	20,0-30,0	10,0-20,0	< 10,0
3.	Social and economical					
3.1	Possibility of population employment at the local level, %	<15,0	15,0-25,0	25,0-35,0	35,0-45,0	>45,0
3.2	Population working in agriculture, % ratio to total working population	<4,0	4,0-9,0	9,0-14,0	14,0-18,0	>18,0
3.3	Land use of private households, in average, ha	< 0,01	0,01-0,10	0,10-0,15	0,15-0,25	≥0,25
Rural settlement social development level		1	2	3	4	5
		Very unsatisfactory	Unsatisfactory	Satisfactory	Good	Excellent

Using the calculated indexes one can characterize ecological and social situation of rural settlement territory:

from 0 to 1,00 - Very unsatisfactory;

from 1,00 to 2,00 – Unsatisfactory;

from 2,00 to 3,00 – Satisfactory;

from 3,00 to 4,00 – Good;

from 4,00 to 5,00 – Excellent.

Apart from determination of general integral ecological and social index the tables can be used to define the indexes of **1.** Priority order of necessary changes; **2.** Lands that need careful consideration; **3.** Land that need improvement; **4, 5** – Lands that should be supported on the same level.

Conclusions. The worked out methodology enables determination of general integral ecological and social index and indexes that influence ecological and social situation and the priority order for lands to be improved for further development of a certain rural settlement territory.

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МЕТОДИКА ВИЗНАЧЕННЯ ЕКОЛОГІЧНО-СОЦІАЛЬНОЇ ОЦІНКИ ТЕРИТОРІЙ СІЛЬСЬКИХ НАСЕЛЕНИХ ПУНКТІВ УКРАЇНИ

І.М. Пустовіт

Розроблена методика, за допомогою якої можна визначити екологічно-соціальний стан територій сільських населених пунктів України за основними критеріями (умовами землекористування, якості ґрунту, радіолого-токсикологічними, санітарно-гігієнічними, демографічними, інфраструктурними, соціально-економічними) для прогнозування їх розвитку.

Ключові слова: екологічно-соціальна оцінка, території сільських населених пунктів, екологічні критерії, соціальні критерії, навколишнє природне середовище, сталий розвиток.

МЕТОДИКА ОПРЕДЕЛЕНИЯ ЭКОЛОГИЧЕСКИ-СОЦИАЛЬНОЙ ОЦЕНКИ ТЕРРИТОРИЙ СЕЛЬСКИХ НАСЕЛЕННЫХ ПУНКТОВ УКРАИНЫ

И.Н. Пустовит

Разработана методика, с помощью которой можно определить экологически-социальное состояние территорий сельских населенных пунктов Украины за основными критериями (условиями землепользования, качества почв, радиолого-токсикологическими, санитарно-гигиеническими, демографическими, инфраструктурными, социально-экономическими) для прогнозирования их развития.

Ключевые слова: экологически-социальная оценка, территории сельских населенных пунктов, экологические критерии, социальные критерии, окружающая природная среда, устойчивое развитие.