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COMPARATIVE ASSESSMENT OF SAFETY AND QUALITY OF DRINKING WATER OF REGIONS OF UKRAINE

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Анотація

Запропоновано схему агрегування показників для порівняльного оцінювання безпечності та якості питної води у розрізі регіонів України. Представлено результати оцінювання регіонів України за індексом безпечності та якості води для 2019 року.

Ключові слова: агрегування, безпечність та якість питної води, індекс, оцінювання, показник, регіон, ЦСР.

Abstract

The aggregation framework of indicators for comparative assessment of safety and quality of drinking water is proposed in the context of regions of Ukraine. The results of the evaluation of the regions of Ukraine by the index of water safety and quality for 2019 year are presented.

Keywords: aggregation, assessment, index, indicator, region, safety and quality of drinking water, SDGs.

Introduction

The Ukrainian national Sustainable Development Goals (SDGs) system consists of 86 national SDGs targets with benchmarks and about two hundred national SDGs monitoring indicators [1]. The environmental dimension of SDGs covers four goals, one of which is «Ensure availability and sustainable management of water and sanitation for all» or SDG 6 «Clean water and sanitation» for short.

Progress in the achievement of five national targets of SDG 6 is measured using 12 indicators. National target "Provide access to quality services of safe drinking water, and ensure the construction and reconstruction of centralized drinking water supply systems using the latest technologies and equipment" is evaluated by five indicators, namely

- safety and quality of drinking water by microbiological parameters (% of non-standard samples; by place of residence and by type of water supply);
- safety and quality of drinking water by radiation parameters (% of non-standard samples; by place of residence and by type of water supply);
- safety and quality of drinking water by organoleptic, physico-chemical and sanitarytoxicological parameters (% of non-standard samples; by place of residence and by type of water supply);
- share of the rural population with access to centralized water supply, %;
- share of the urban population with access to centralized water supply, %.

Access to centralized water supply are not provided in 4 of 406 cities and towns, 60 of 683 urban-type settlements (uts), and 19059 of 26076 villages in Ukraine, 730 localities (3 towns, 14 uts, and 713 rural ones) are completely dependent on outside water supplies (transported water) [2]. The high level of anthropogenic burden and the use of outdated drinking water treatment technologies (the use of chlorine, inefficient coagulants etc.) result in provision of drinking water with low safety and quality parameters. The benchmarks for safety and quality of drinking water by microbiological, radiation, and sanitary and chemical parameters are still under development on national level. In view of this, the paper is an attempt to evaluate drinking water quality for regions of Ukraine in comparative context.

The index of water safety and quality

The index of water safety and quality is proposed based on data sets and indicator prepared by the Ministry of communities and territories development of Ukraine annually [3]

$$I_{wsq,i}=(I_{cq,i}+I_{bq,i})/2, \quad (1)$$

where $I_{cq,i}$ is the index of safety and quality of drinking water by sanitary and chemical parameters for region i and $I_{bq,i}$ is the index of safety and quality of drinking water by bacteriological parameters for region i:

$$I_{cq}=w_{urb,i}\times x_{cu,i}+w_{rur,i}\times x_{cr,i}+w_{nc,i}\times x_{cn,i}, \quad (2)$$

where $x_{cu,i}$ is the logistically normalized value [4] of the share of non-standard samples by sanitary and chemical parameters in urban water supply systems (tap water) of region i, $x_{cr,i}$ is the logistically normalized value of the share of non-standard samples by sanitary and chemical parameters in rural water supply systems of region i, $x_{cn,i}$ is the logistically normalized value of the share of non-standard samples by sanitary and chemical parameters for non-centralized water supply sources of region i, $w_{urb,i}$ is the share of the urban population with access to centralized water supply of region i, $w_{rur,i}$ is the share of the rural population with access to centralized water supply of region i, $w_{nc,i}$ is the share of the population without access to centralized water supply of region i and

$$I_{bq}=w_{urb,i}\times x_{bu,i}+w_{rur,i}\times x_{br,i}+w_{nc,i}\times x_{bn,i}, \quad (3)$$

where $x_{bu,i}$ is the logistically normalized value [4] of the share of non-standard samples by bacteriological parameters in urban water supply systems (tap water) of region i, $x_{br,i}$ is the logistically normalized value of the share of non-standard samples by bacteriological parameters in rural water supply systems of region i, $x_{bn,i}$ is the logistically normalized value of the share of non-standard samples by bacteriological parameters for non-centralized water supply sources of region i.

A comparative evaluation of water quality for regions of Ukraine

The 2019 index of water safety and quality is evaluated for regions of Ukraine (Table 1). Data exclude the temporarily occupied territory of the Autonomous Republic of Crimea (ARC), the city of Sevastopol, and a part of temporarily occupied territories in the Donetsk and Luhansk regions.

Table 1

Comparative water quality for regions of Ukraine

Region	I_{cq}	I_{bq}	I_{wsq}	*Region*	I_{cq}	I_{bq}	I_{wsq}
ARC	n/a	n/a	n/a	***oblasts***			
oblasts				Odesa	0.284	0.308	0.296
Vinnytsya	0.301	0.047	0.174	Poltava	0.631	0.510	0.570
Volyn	0.705	0.742	0.724	Rivne	0.381	0.273	0.327
Dnipropetrovsk	0.550	0.517	0.534	Sumy	0.472	0.609	0.540
Donetsk	0.300	0.220	0.260	Ternopil	0.423	0.549	0.486
Zhytomyr	0.444	0.345	0.395	Kharkiv	0.463	0.452	0.457
Zakarpattya	0.716	0.375	0.545	Kherson	n/a	n/a	n/a
Zaporizhzhya	0.359	0.619	0.489	Khmelnytskiy	n/a	n/a	n/a
Ivano-Frankivsk	0.745	0.446	0.596	Cherkasy	0.630	0.464	0.547
Kyiv	0.420	0.433	0.427	Chernivtsi	0.737	0.633	0.685
Kirovohrad	0.362	0.544	0.453	Chernihiv	0.638	0.631	0.635
Luhansk	0.086	0.759	0.423	***cities***			
Lviv	0.695	0.463	0.579	Kyiv	0.752	0.727	0.740
Mykolayiv	0.645	0.700	0.672	Sevastopol	n/a	n/a	n/a

The part of used data are taken from other annual national reports on water quality [3] as it is shown in Table 2 since in the latest one (the 2019 report [2]) some data are not available. The overall ranking of the regions of Ukraine by values of the index of water safety and quality shown in Table 3.

The leader of the safety and quality of drinking water by sanitary and chemical parameters and bacteriological parameters among regions of Ukraine under assessment is Kyiv. This region is also a leader by the index of safety and quality of drinking water by sanitary and chemical parameters. Volyn and Chernivtsi oblasts are the best performers in water quality provision too.

The 2019 outsider of the safety and quality of drinking water is Vinnytsya oblast. This region and Donetsk and Odesa oblasts have the lowest values of the water safety and quality index.

Table 2

Water quality of sources and water supply systems (2019 data year)

Region	*the share of non-standard samples by sanitary and chemical parameters, %*			*the share of non-standard samples by bacteriological parameters, %*		
	non-centralized sources	*water supply systems*		*non-centralized sources*	*water supply systems*	
		urban	*rural*		*urban*	*rural*
ARC	n/a	n/a	n/a	n/a	n/a	n/a
oblasts						
Vinnytsya	63.2	26.2	39.4	66.8	29.4	40.9
Volyn	22.3	1.2	8.3	5.0	0.7	4.2[2]
Dnipropetrovsk	37.9	14.5	58.4	16.1	7.6	18.0
Donetsk	63.5[2]	22.8	20.0	41.1[2]	17.4	10.3[2]
Zhytomyr	36.1	28.9	41.9	36.6	10.0	16.0
Zakarpattya	14.7	8.6	12.8	27.7	15.3	10.6
Zaporizhzhya	71.6	25.6	39.2	20.3	3.9	6.1
Ivano-Frankivsk	14.0	2.3	8.6	35.0	2.5	6.0
Kyiv	46.8	24.8	38.7	28.3	10.2	14.0
Kirovohrad	64.1	27.0	29.4	19.7	6.8	8.0
Luhansk	84.0	61.6	90.9	2.0	0.7	2.7
Lviv	22.6	4.2	5.4	32.3	5.9	6.4
Mykolayiv	22.0	5.0	37.0	0.9	0.4	12.6
Odesa	53.7[2]	37.1	41.0	24.5[2]	15.0	17.0
Poltava	32.6[1]	8.9	7.3	5.1[1]	13.1	11.5
Rivne	36.4	42.9	47.4	33.3	17.0	23.0
Sumy	20.0	27.0	50.0	15.1[1]	5.2	5.6
Ternopil	26.8	46.5	28.0	22.8	3.8	24.5
Kharkiv	45.7	21.0	24.3	29.8	8.1	15.8
Kherson	n/a	48.0	n/a	n/a	2.0	n/a
Khmelnytskiy	8.4[2]	3.8	n/a	5.8[2]	2.5	n/a
Cherkasy	18.9	15.6	23.0	14.3	14.0	10.4
Chernivtsi	16.8	0.3	0.0	12.5	4.7	9.2
Chernihiv	30.2	6.7	15.9	14.2	4.1	4.6
cities						
Kyiv	21.4[1]	1.7[1]	—	5.3[1]	1.2[1]	—
Sevastopol	n/a	n/a	—	n/a	n/a	—

[1]2018 data year; [2]2017 data year

Table 3

Ranking of regions of Ukraine by values of the index of water safety and quality (in descending order)

Region	I_{cq} *rank*	I_{bq} *rank*	I_{wsq} *rank*	*Region*	I_{cq} *rank*	I_{bq} *rank*	I_{wsq} *rank*
City of Kyiv	1	3	1	ARC, Sevastopol city, Kherson and Khmelnytskiy oblasts	n/a	n/a	n/a
oblasts							
Volyn	5	2	2	Zaporizhzhya	19	7	13
Chernivtsi	3	5	3	Ternopil	15	9	14
Mykolayiv	7	4	4	Kharkiv	13	15	15
Chernihiv	8	6	5	Kirovohrad	18	10	16
Ivano-Frankivsk	2	16	6	Kyiv	16	17	17
Lviv	6	14	7	Luhansk	23	1	18
Poltava	9	12	8	Zhytomyr	14	19	19
Cherkasy	10	13	9	Rivne	17	21	20
Zakarpattya	4	18	10	Odesa	22	20	21
Sumy	12	8	11	Donetsk	21	22	22
Dnipropetrovsk	11	11	12	Vinnytsya	20	23	23

In most cases positions of outsiders of the ranking can be explained by decrease of water quality in the sources of water supply, the deterioration of water treatment equipment, and/or high man-made load (agricultural sector, utilities, or industrial sector; it depends on specificity of the region's economy). For example, the quality of the water in the river basin of Pivdennyi Buh (the *Southern Bug* river), the main source of water supply for Vinnytsya oblast, has deteriorated. The share of non-standard samples by microbiological parameters was 87% and by sanitary and chemical parameters was 93% for this water supply source in 2018 year [5].

Conclusions

The integrated indicator framework for the safety and quality of drinking water assessment on the regional level is proposed. Assessment results in the regional context of the 2019 index of water safety and quality and its components are obtained. Despite the benchmark approach is not used, the results indirectly represent the progress made towards the achievement of the national SDG 6 «Clean water and sanitation» on the regional level. The proposed water safety and quality index may be used as a stand-alone index or integrated into the environmental dimension of a more complex framework for regional sustainability assessment.

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