

INTEGRATED SOCIO-ECONOMIC CRITERIA OF TRANSBOUNDARY WATER USE

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A crucial, albeit finite, resource, water is vital to country's economic and social development and it is the cornerstone of sustainable development. Many countries share water resources and transboundary water-related problems are growing more complex and acute worldwide, and habitats are facing critical challenges: lack of water supply and sanitation, growing conflicts and competition for the use of freshwater and deteriorated environments. These troubles point to the fact that today's water problem is largely one of governance.

Ukraine is one of the largest European Countries and shares almost all big river basins with other countries, including EU. There is 80% of drinking water supply from surface water, including transboundary one, in Ukraine. The situation is getting more sophisticated because of growing water pollution and degradation. In 2006, there are 62% of analysed water samples from drinking water sources not correspond the Ukrainian Water Quality Standard.

The sound evaluation of transboundary water use efficiency, based on the principles of sustainable development, must be carried out on multiple levels, including relevant environmental, economic and social aspects of water use [1]. Measuring sustainability lists in a various decision-making concepts to include the complex criteria generation for further comparing [2]. Sustainability indicators are effective means whether the city, region or any management system is moving towards sustainable development [3].

In fact, different approaches to criteria generation and their use for evaluation have been developed in a number of water-use sustainability studies [4-6], most of them are complicated for quantitative estimation, specific and locally oriented.

As a country with a transition economy and a country which uses transboundary water basins, Ukraine has an excellent position to benefit from a new sustainability evaluation system for natural resources consumption.

The aim of our research is to create the easy evaluated integrated indicator of evaluation of water use efficiency to be used for regional and national levels.

The following major water use indicators should be taken in account for criteria generation: water value of GDP, total water consumption, polluted water discharged, population which has access to water, efficiency of water treatment processes, etc.

Economic development can cause degradation of natural environment, as it results into the growth of energy and resources consumption. Therefore, the less a region needs in water resources for forming GDP unit, the more efficient in economic sense is water management there. Thus, the indicator of economic efficiency of water use ($K_{i,econ}$) can be calculated as:

$$K_{i,econ} = W_i / GDP_i \cdot m^3 / UAH$$

Where W_i – total water consumption in the region (country) – i , m^3 ;

GDP_i – Gross domestic product of the region (country), money units (1UAH=0,2USD)

It is appropriate to define environmental efficiency of water use, as a return of untreated water into natural environment. In that way, the environmental indicator of water use sustainability ($K_{i,env}$) can be calculated as a part of untreated water in total amount of consumed water in the region (country):

$$K_{i,env} = W_{i,tw} / W_i \text{ non-dimensional}$$

$W_{i,tw}$ – amount of untreated water, m^3 /year.

Social efficiency of water use is the most sophisticated indicator in both substantial and calculation senses. Conceptually, the social efficiency of water use is a minimization of water consumption level for the satisfactions of needs of a society. Consumption of water in cities is approximately 300-600 liters per capita per day, what is higher, then in rural areas, where consumption of water is approximately 100-120 liters per capita per day. The same level of water consumption can be more or less efficient in social sense with different levels of water needs. The last depends on cultural differences, environmental and climatic conditions, structure of economy, policies of a government, law and so on. It is impossible to obtain quantitative data about water need on regional and national levels without special researches. Furthermore this data can't have high level of reliability because of the subjectivity of the term "needs". Therefore, it is proposed to define social efficiency of water use as a ratio of current water consumption per person in a region to the basic or sample level of water consumption per person. Then, the problem of sample choice appears. In that case, social efficiency of water use has been calculated as a ratio of water consumption level per person in a region to the average level of water consumption level per person in Ukraine.

$$K_{i,soc} = W_s / W_{s,bas}, \text{ non-dimensional}$$

Where W_s specific water consumption in a region per person, m^3 per person

$W_{s,bas}$ – basic index of specific water consumption per person in a region, m^3 per person.

It is proposed to integrate three mentioned indexes of water use efficiency and to calculate integrated index of water use sustainability in the following way:

$$I_{ees} = K_{econ} \times K_{env} \times K_{soc}, \text{ cub.m/UAH}^*$$

The definition $I_{ees} \rightarrow 0$ means the growth of water use sustainability.

This integrated criterion has been used for analysis of water use sustainability and wastewater treatment in all administrative and economic regions of Ukraine in the framework of the scientific research project, managed by the Ministry of Environmental Protection of Ukraine and Academy of Science, Ukraine. Based on the proposed criteria the water governance problem and critical directions of water use and water treatment policies have been estimated for different regions of Ukraine.

The analysis uncovered a breakdown of Ukraine's regions into three groups: low sustainability of water use (Odessa, Khersonska, Crimea Republic), medium sustainability of water use (Dnipropetrovska, Donetsk, Zaporizka, Kievska), satisfied sustainability of water use (other regions). For every region of Ukraine, factor analysis has been applied to estimate the influences of environmental, economic and social indexes on water use efficiency. Also the results show that the sustainability of water use is strongly depends on the economic structure of the region and the integrated criteria have been calculated for the economic zones of Ukraine (figure 1).

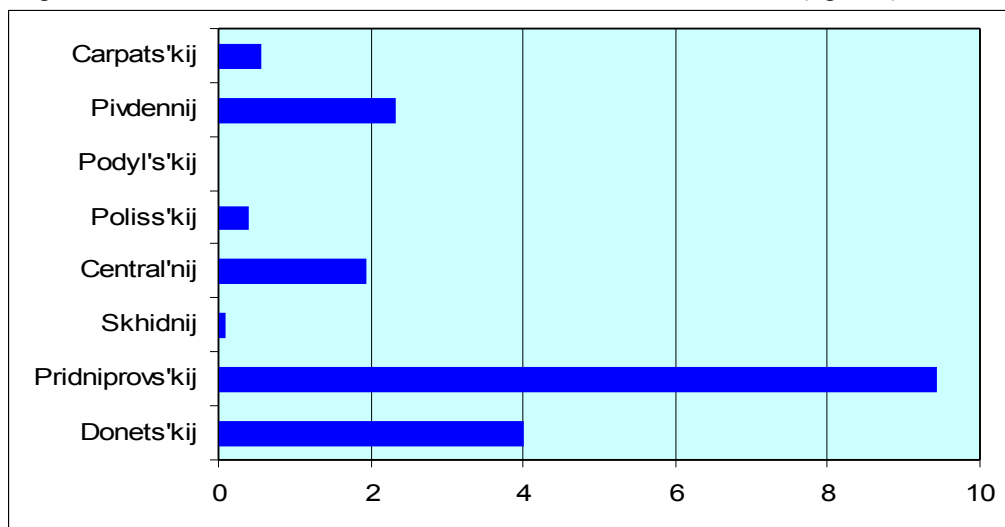


Fig.1 Sustainability of water use in economic zones of Ukraine

Thus, the most difficult situation with water use is in the Eastern part of Ukraine (Pridniprovs'kiy and Donets'kij economic zones). These regions are the most economically active in Ukraine with high water value of production and very small, if compare to other regions, water tariff. Pridniprovs'kiy and Donets'kij economic regions use such big transboundary river basins as Dnipro and Severskiy Donets and increase the anthropogenic pressure on it. Also the Pivdennij economic region can be characterized as low sustainability water use region. The local economic activity of this region is low, but the region specializes on high water value agriculture production and it is the most water scarcity area of Ukraine. But at the same time the high level of polluted wastewaters come to the transboundary water bassins of the region. The regional water use efficiency analysis shows that water problems of Ukraine are very closely connected with production activities allocation in the country. High water value production is located on the water scarcity regions and it leads to intensive and distructed water use of neighbours natural resources, including transboundary one.

Also, proposed integrated criterion has been applied to analyse the situation with water use sustainability in countries which have common borders with Ukraine and share the common surface river basins: Romania, Slovakia, Poland, Russia, Belarussia, Moldova, Hungary. The results are presented in the Table.

Table - Sustainability of water use in some countries of Eastern Europe

Country	K_{econ} , m ³ /UAH*	K_{env}	Water consumption level, l/cap/day	K_{soc}	I , m ³ x 10 ³ /UAH
Ukraine	0,0280	0,3380	219,6	0,7153	6,7660
Belarussia	0,0217	0,5522	177,3	0,5777	6,9134
Moldova	0,0856	0,0115	189,3	0,6165	0,6047
Romania	0,0443	0,800	405,3	1,3204	46,7712
Hungary	0,0293	0,0515	521,7	1,6996	2,5597
Poland	0,0214	0,0787	295,3	0,9618	1,6188
Slovakia	0,0095	0,1010	162,5	0,5360	0,5110
Russia	0,0379	0,2958	451,5	1,4708	16,4784
Average	0,0347	0,2786	302,8	0,989	10,2896

The impact of different regions on the use of water from transboundary river basins can be evaluated with the focus on the main vectors of sustainability: economy, environment, society. According to the results, the weak points can be found in water use scheme (for example the social indicator is high and society use a lot of water resources to satisfy its needs, thus the investments and recommendations on water use sustainability should be focused on households and involvement of society in water saving programmes). Also, it is possible to develop the correction coefficient for the water use tariff with application of the indicator and it would be the economic tool to increase the sustainability of transboundary water use.

Increasing of water use sustainability helps to prevent conflicts between main users of transboundary water basins. The criterion is quantitative and with use of factor analysis the share the impact of each user on transboundary water can be evaluated.

The results of our research will have a perspective for the easy sustainability evaluation of certain transboundary river basins and analysis of water and wastewater management on national and regional levels, and in the development of regional recommendations for improving water use sustainability and reforming the tariff system. The proposed method helps the decision-making and policy formulation processes more accountable and increases the effectiveness of water use in Ukraine and in other countries.

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