METHODOLOGY FOR EFFICIENCY OF WATER MANAGEMENT

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Abstract

In the paper has been analyzed methodology for efficiency of water management. Creation of an information array based on official statistics of Uzbekistan, including spatial and dynamic characteristics of water consumption, as well as indicators of economic growth of the economy as a whole and agricultural production. Performing statistical cluster analysis in order to identify homogeneous groups of regions of the Republic of Uzbekistan in terms of water consumption and economic growth in the economy and the agricultural sector.

Carrying out a quantitative "causal" analysis in order to identify and assess the direction of the relationship between indicators of the dynamics of water consumption in agriculture and indicators of economic growth, assess the specifics of these relationships for individual regions and regional clusters.

Keywords: water, management, socio-economic efficiency of water consumption, agriculture, water management system, analyzing, monitoring.

МЕТОДОЛОГИЯ ЭФФЕКТИВНОГО УПРАВЛЕНИЯ ВОДНЫМИ РЕСУРСАМИ

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Аннотация

В статье проанализирована методология повышения эффективности управления водными ресурсами. Исследуются вопросы создания информационного массива на основе официальной статистики Узбекистана, включающего территориальные и динамические характеристики водопотребления, а также показателей экономического роста экономики и сельскохозяйственного производства.

Проведен статистический кластерный анализ с целью выявления однородных групп регионов Республики Узбекистан по показателям водопотребления, экономического роста и развития аграрного сектора. Осуществлен количественный «причинный» анализ с целью выявления и оценки направления связи показателей динамики водопотребления в сельском хозяйстве с показателями экономического роста, оценки специфики этих связей для отдельных регионов и региональных кластеров.

Ключевые слова: вода, управление, социально-экономическая эффективность водопотребления, сельское хозяйство, водохозяйственная система, анализ, мониторинг.

SUV RESURSLARINI SAMARALI BOSHQARISH METODOLOGIYASI

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texnika fanlari nomzodi
O‘zbekiston Respublikasi kasaba uyushmalari
Federatsiya raisining o'rinbosari

Annotatsiya

Maqolada suv resurslarini boshqarish samaradorligini oshirish metodologiyasi tahlil qilingan. O‘zbekistonning rasmiy statistik ma’lumotlari, jumladan, suv iste’molining hududiy-dinamik ma’lumotlari, shuningdek, iqtisodiy o‘sish va qishloq xo‘jaligi mahsulotlari ishlab chiqarish ko‘rsatkichlari asosida axborot majmuasini yaratish masalalari o‘rganilgan.

Suv iste’moli, iqtisodiy o‘sish va qishloq xo‘jaligini rivojlantirish bo‘yicha O‘zbekiston Respublikasi hududlarining bir xil guruhlarini aniqlash maqsadida statistik klaster tahlili o‘tkazildi. Qishloq xo‘jaligida suv iste’moli dinamikasi va iqtisodiy o‘sish ko‘rsatkichlari o‘rtasidagi bog‘liqlikni aniqlash hamda alohida hududlar va hududiy klasterlar bo‘yicha ushbu bog‘lanishlarning o‘ziga xos xususiyatlarini baholash maqsadida miqdoriy “sabab-oqibat” tahlili o‘tkazildi.

Kalit so'zlar: suv, boshqaruv, suv iste'molining ijtimoiy-iqtisodiy samaradorligi, qishloq xo'jaligi, suv xo'jaligi tizimi, tahlil, monitoring.

Introduction

Efficiency in water management aims to increase the productivity of the available water by reducing its misuse and wastage. Efficiency in water management aims to align water demand and water supply through a multi-pronged approach at different levels considering social, economic, technical, institutional, and environmental factors. Tools in this sub-section give indications on how to improve water efficiency from the supply and demand perspectives as well as discusses the potential for water reuse and recycling [1].

The competition for existing freshwater supplies will require a paradigmatic shift from maximizing productivity per unit of land area to maximizing productivity per unit of water consumed. This shift will, in turn, demand broad systems approaches that physically and biologically optimize irrigation relative to water delivery and application schemes, rainfall, critical growth stages, soil fertility, location, and weather. Water can be conserved at a watershed or regional level for other uses only if evaporation, transpiration, or both are reduced and unrecoverable losses to unusable sinks are minimized (e.g., salty groundwater or oceans). Agricultural advances will include implementation of crop location strategies, conversion to crops with higher economic value or productivity per unit of water consumed, and adoption of alternate drought-tolerant crops. Emerging computerized GPS-based precision irrigation technologies for self-propelled sprinklers and microirrigation systems will enable growers to apply water and agrochemicals more precisely and site specifically to match soil and plant status and needs as provided by wireless sensor networks. Agriculturalists will need to exercise flexibility in managing the rate, frequency, and duration of water supplies to successfully allocate limited water and other inputs to crops. The most effective means to conserve water appears to be through carefully managed deficit irrigation strategies that are supported by advanced irrigation system and flexible, state-of-the-art water delivery systems. Nonagricultural water users will need to exercise patience as tools reflecting the paradigmatic shift are actualized. Both groups will need to cooperate and compromise as they practice more conservative approaches to freshwater consumption [15].

Literature review

The task of developing and analyzing indicators of water consumption in agriculture, systemically related to the corresponding indicators of water consumption in other sectors and sectors of the economy, V.V. Kundius [4], N. Zharnitskaya [5], I. Abdullaev [6], P. Gober [8], V.I. Danilov-Danilyan [10], as well as indicators of socio-economic efficiency, was set at the 24th session of the FAO “Water Resources Management for Agriculture and Food security” (Rome, 29.09 – 03.10.2014), where it was noted: “Agriculture, whose needs in total water consumption are estimated at 70%, is increasingly claiming its own share of water resources for food production and ensuring food security. At the same time, the rationality of water use for agricultural purposes is under increasing scrutiny” [2].

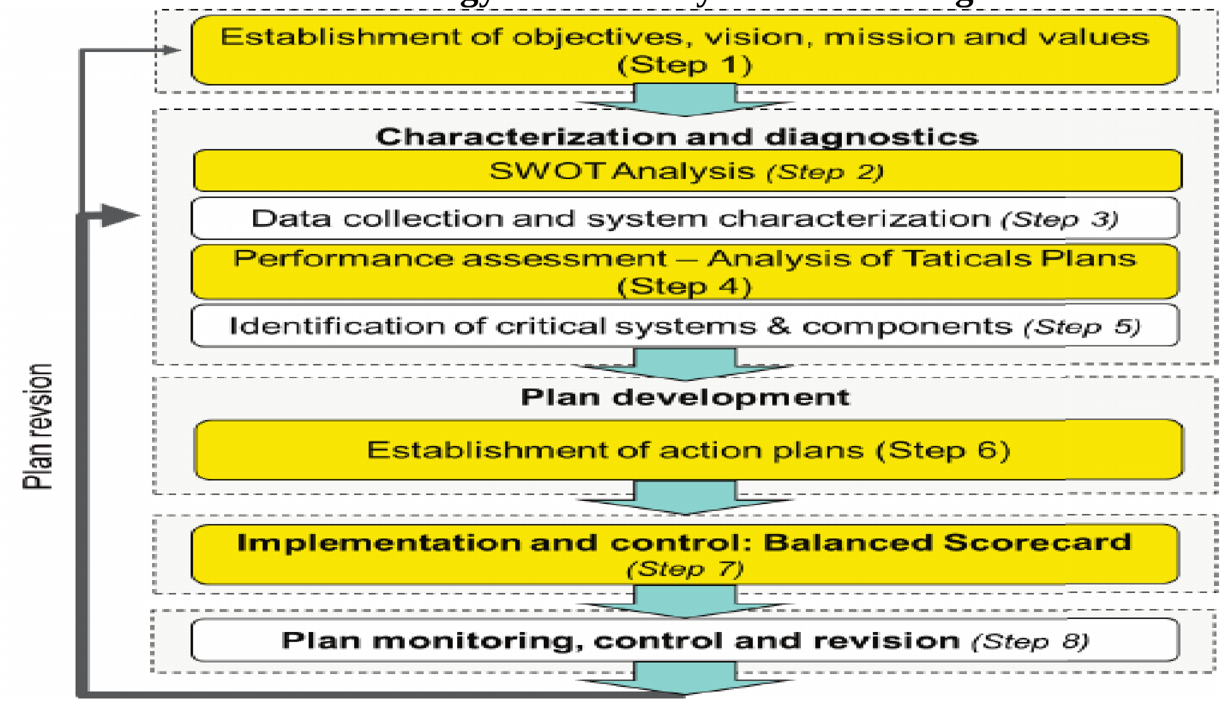
The presented review of literature sources, on the one hand, demonstrates the insufficient representation in them of an important area of quantitative research that requires development both in methodological and informational terms. Namely: the formation on the basis of open data sources of tools for modeling and analyzing the "response" of macroeconomic indicators at the level of the country and regions to changes in the volume of water consumption in agriculture [7].

This direction is very relevant for the Republic of Uzbekistan and the regions in connection with the above Concept for the Development of the Water Resources of the Republic of Uzbekistan for 2020-2030, the task of constantly monitoring the achievement of the main target indicators for improving the efficiency of the use of water resources.

On the other hand, the presented review of the works makes it possible to take into account their individual aspects in the formation of the purpose and objectives of this study.

Fig 1.

Methodology for efficiency of water management



The Strategic Committee plays a key role in this process. From these results, one should undertake periodic review of action plans in relation to the objectives, as well as SWOT analysis, because the internal and external conditions change, requiring a reassessment of the action plans. This allows the evaluation of the efficiency of human resources, physical and technological resources, as well as the effectiveness of actions, comparing the baseline configuration with the final plan. The HAGAPLAN is a Consultancy Company and it is in consortium with

SANEAR, which is developing a work to reduce losses in Guarulhos. So is underway to apply the methodology described above. In the complex context of the water of the great metropolis that surrounds the city of São Paulo, Guarulhos is one of six autonomous systems. However, although it has complete independence in relation to the distribution of water, the city's main supplier Sabesp - Basic Sanitation Company of the State of São Paulo, which supplies the region through the Metropolitan Aqueduct System. Since the last two decades of the twentieth century the supply of drinking water produced by us for the MRSP has been limited, and the prospect of population growth, mainly concentrated in layers of middle and low income located in peripheral regions, the municipality is seeking to increase its autonomy in terms of water production, mainly through the implementation of systems independent producers, rooted in the exploration of deep wells with low flow and small watersheds in the region. Despite significant investments that have been made since 2001, distributor system, even if no progress on increasing efficiency, and to pursue the full implementation of the supply sectors designed in previous studies and in other structures that may contribute to the effective control of drinking water distributed. An increase in efficiency translates into an obviously reducing the amount of water distributed and therefore a greater protection of resources, without compromising the quality of services provided by SAAE its users [14].

Analysis of results

In accordance with the Law of the Republic of Uzbekistan "On official statistics" (2021), state statistical bodies must "provide statistical data to public authorities and administrations"; at the same time, they carry out "integration with information systems of state and economic administration bodies, as well as local executive authorities in order to conduct statistical observations, generate and analyze official statistical data" [11].

The presented indicators make it possible to form a hypothetical directed graph of information links (Fig. 1), which includes direct (solid arrows) and indirect (dashed arrows) mutual influence of indicators characterizing water consumption in the economy as a whole and agriculture and the corresponding indicators of economic growth. The objectives of this study included a statistical assessment of the directions and strength of the connection of the graph elements based on the generated data array for the regions of Uzbekistan, as well as an assessment of the response of the economic growth of the regions due to the growth of agricultural production (, due to changes in the volume of water consumption in $\Delta_{1\,(t)}$)agriculture ($\Delta_{2\,(t)}$)[9] .

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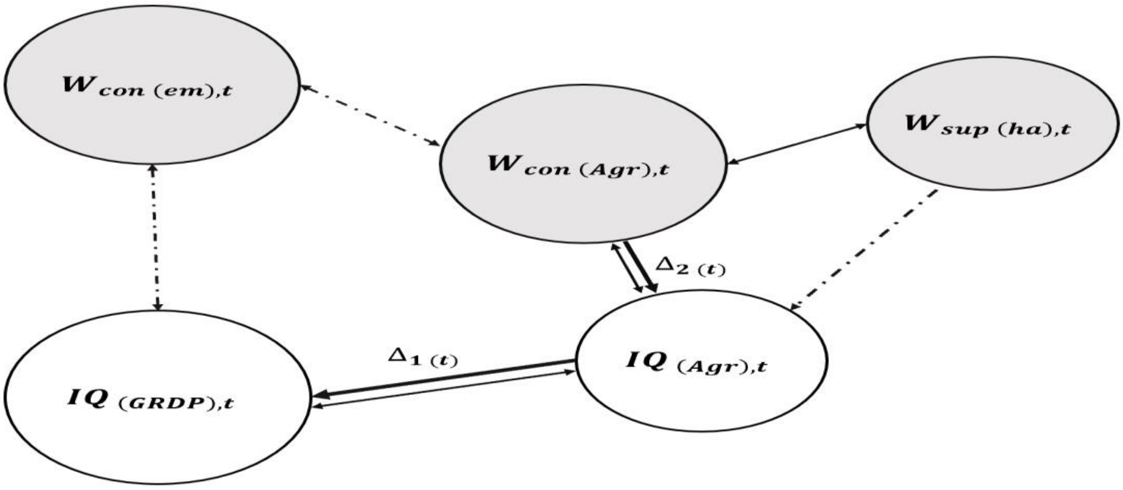
The presented graph also indicates the two-way orientation of the cause-and-effect relationships of the indicators under consideration (this is reflected in the figure with the help of two-way arrows). With this in mind, the problem of estimating the priority direction of the causal relationship between the indicators under consideration was solved to include them in the model, the resulting values of which are the response indicators (and) of $\Delta_{1\ (t)}$economic $\Delta_{1\ (t)}$growth and the growth of agricultural production to the dynamics of water consumption in agriculture (in Fig. 1 indicated by unidirectional arrows).

The formed information base of the study made it possible to perform a cluster analysis by years delimiting the study period (2015 and 2022), as well as by years of the "post-COVID" period (2020 and 2021). Hierarchical cluster analysis was performed by Ward's method (Ward 's method) using the "Euclidean" distance estimation metric (Euclidian distance) between population units.

Fig.1.

Graph of links (hypothetical) of indicators of official statistics characterizing the efficiency of water consumption in agriculture of the regions of the Republic of Uzbekistan*



* Author's development.

As follows from the data in Table 1, there has been a change in the cluster composition over the years under consideration. To study the depth of time lags taken into account when analyzing the direction and strength of causal relationships between indicators, it is necessary to assess how significant the divergence of the cluster composition of regions is in certain intervals, and then take the lag for estimating the relationships of indicators over the time interval with the largest change in the cluster composition.

Table 1 presents two-input contingency tables containing the results of the distribution of regions in two clusters in the compared years (2023 and 2015 and 2022 and 2021).

Table 1.

Assessing the contingency of the results of clustering the regions of the Republic of Uzbekistan in terms of the efficiency of water consumption in agriculture: (a) 2015 – 2023

2015 / 2022	Cluster 1	Cluster 2	Total
Cluster 1	6	1	7
Cluster 2	3	3	6
Total	9	4	13

(b) 2021 – 2023

2021 / 2022	Cluster 1	Cluster 2	Total
Cluster 1	5	2	7
Cluster 2	4	2	6
Total	9	4	13

Evaluate the similarity between two cluster partitions, the Fowlkes - Mallows index can be used. index) [12].

The assessment of this index (FM) was carried out according to the method described in the Internet resource “Quality Assessment in the Clustering Problem” [13]. The following values were used:

TP is the number of elements belonging to the same cluster in both years (in the first case: 2015 and 2022);

FP is the number of elements belonging to the same cluster in the base year (2015) but to different clusters in the compared year (2022);

FN is the number of elements belonging to the same cluster in the compared year (2022) but to different clusters in the base year (2015).

FM index is calculated using the formula:

$$FM = \sqrt{\frac{TP}{TP+FP} * \frac{TP}{TP+FN}}.$$

According to Table 2 (a), the value of the FM index was 0.43, and according to the data of the same table, but point (b), it was 0.35.

A higher index value means greater similarity between the clustering of regions in the indicated years.

It can be concluded that in the last years of the “post-COVID” period, an increase in "territorial stratification", i.e. in this study, the differentiation of regions in terms of the efficiency of water consumption in agriculture was significantly more intense than in the previous eight-year period.

Conclusions and recommendations

The methodology developed by Jimenez-Bello et al. (2010a) in which intake operation is scheduled in such a way that energy use is minimised has been improved by allowing each intake to operate only within the scheduled time. In this way, crop water requirements can be satisfied more efficiently and intakes are not restricted to operating in fixed time periods.

Major water-saving improvements from irrigation in the future will be realized largely through the management and innovative design of integrated water delivery and field irrigation systems for both agrarian and urban settings. Rural and urban irrigators will have to improve productivity per unit of water consumed. However, doing so will require major systematic cultural, managerial, engineering and institutional changes. This must be supported by system-wide enhancement of water delivery systems, advanced site-specific irrigation technologies that include self-propelled sprinklers and microirrigation systems, and other supporting monitoring, modeling and control technologies. Decision support tools will be needed to assist growers and managers in optimizing the allocation of limited water among crops, selection of crops by regions, and adoption of appropriate alternative crops in drought years.

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