Specific and integral efficiency use of land and water resources

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Abstract. The article provides information on the importance of land and water resources, which are the basis of agriculture, including the regional efficiency of land and water resources in the example of Samarkand region, the situation within the districts. To do this, the share of districts in agricultural production, the percentage of land and water resources is expressed in comparable indices (\(i = 1\)). The specific (land and water resources separately) and integral (combined land and water resources) aspects of land and water use efficiency were calculated in two ways (brutto and netto). Specific efficiency was determined by the state of water use at the expense of the regional agricultural lands and the Zarafshan Basin Department of Irrigation Systems. In order to more accurately reflect the results of the study, the districts were divided into four groups according to the net (net) efficiency status, and each group was named based on a certain criterion. In addition, differences in the use of land and water resources by districts were identified using differences in netto and brutto efficiency. The results are tabulated in order to change the situation by region and to show the situation more clearly. At the end of the article, suggestions and recommendations for improving the efficiency of land and water use in the districts of the region are given.

1. Introduction
The issue of rational use of natural resources, including land and water resources, has been much discussed over the last years. This process is especially important in countries specializing in agriculture, especially in Uzbekistan. The organization of rational use of land and water resources has two main goals: the efficient use of land and water resources and their protection [1]. Like other production processes, economic factors play an important role in determining land and water use efficiency. High productivity per unit, the usefulness of the amount per capita, and so on. If efficiency is expressed in the example of a region (region, province, district), it can be recognized as regional efficiency [5].

The purpose of the study is to calculate the efficiency of land and water resources use of districts using their agricultural production. For this purpose, the specific (separate) efficiency of land and water resources use, integrated (joint) efficiency of land and water resources use were calculated, and differences in land and water resources use of the surveyed districts were determined.
2. Methodology and materials

Statistical analysis, interregional comparison, mathematical methods were used in this work. To show the absolute figures clearly, they are expressed in a certain ratio (percentage). Efficiency was calculated in indices relative to the regional average. Here, the indices are determined by the ratio of relative indicators (percentages). The efficiency of land and water use is expressed in brutto and netto ratios. They were calculated by arithmetic mean and geometric mean.

In Samarkand region, agricultural lands (1295.5 thousand hectares) make up about 90% of the total area [7]. In general, large rural districts (Nurabad, Koshrabat) are well provided with agricultural lands. However, most of them are occupied by lands specializing in pastoralism and dry farming (see table 1). On the contrary, in the suburbs there are very little agricultural lands (Taylak, Aqdarya), in addition, the intensive farming has mainly developed there. Pastdargom, Payariq and Kattakurgan districts are well supplied with water resources. The difference in agricultural production is not so great. [1]

**Table 1.** The share of districts in the cultivation of regional agricultural products and the provision of agricultural lands and water resources.

| №  | Districts    | The share of agricultural production $R_a$ | Provision of land resources $R_l$ | The provision of water resources $R_w$ |
|----|-------------|-------------------------------------------|----------------------------------|--------------------------------------|
| 1  | Bulung'ur   | 9.5                                       | 3.6                              | 7.2                                  |
| 2  | Jomboy      | 5.8                                       | 2.2                              | 7.4                                  |
| 3  | Ishnikhon   | 8.4                                       | 3.3                              | 8                                    |
| 4  | Kattakurgan | 7.4                                       | 6.6                              | 10.6                                 |
| 5  | Narpay      | 4.5                                       | 1.9                              | 8.8                                  |
| 6  | Nurobod     | 2.5                                       | 28.0                             | 2                                    |
| 7  | Aqdaryo     | 5.4                                       | 1.6                              | 6.3                                  |
| 8  | Pastdargom  | 8.8                                       | 6.8                              | 14.1                                 |
| 9  | Pakhtachi   | 5.1                                       | 3.9                              | 8.2                                  |
| 10 | Payariq     | 9.3                                       | 7.4                              | 12.5                                 |
| 11 | Samarkand   | 8.5                                       | 1.7                              | 4.5                                  |
| 12 | Tayloq      | 8.8                                       | 1.1                              | 3.9                                  |
| 13 | Urgut       | 10.9                                      | 4.9                              | 6                                    |
| 14 | Koshrabat   | 4.2                                       | 12.7                             | 0.3                                  |
|    | By province | 100                                       | 100                              | 100                                  |

The index of the share of regions in agriculture was calculated on the basis of data for the last 12 years [4]. The index of effective use of land and water resources is calculated in relation to the indicator of land or water supply of the districts (see table 2).

$$I_{cal}(I_{ew}) = \frac{R_a}{R_l(w)},$$

here:

- $I_{cal}(I_{ew})$ (effective use of land or water) – Index of efficient use of land or water resources,
- $R_a$ (ratio of agricultural production) – Ratio in agricultural production,
- $R_l(w)$ (ratio of land or water resources) – the ratio (share) of districts in the provision of land or water resources.

When calculated by this formula, the state of land and water use of the regions arose. Taylak district, which is well-supplied with agro-climatic natural resources, is distinguished by the level of land use,
which is almost eight times higher than the regional average. Along with Taylak, Samarkand district also stands out in the use of agricultural lands. Nurabad and Koshrabat districts are the least developed areas for growing agricultural products from land resources. These districts are the most passive in the agricultural sector of the region. This is directly related to the inconvenience of natural conditions.

In the efficient use of water resources, the situation is slightly different. That is, 50 percent of the districts lag behind the regional average, which is due to the fact that they are provided with more water resources [2]. Interestingly, a very high figure in this regard is observed in Koshrabat district. The fact that the share of this district in the regional water distribution is very small, significantly increases its performance. From this it is clear that the agriculture of this district is dominated by dry farming and animal husbandry. In addition, the index of water efficiency is high in the eastern districts of Taylak, Samarkand and Urgut. The relatively low rate is in Narpay, Pastdargom, Pakhtachi and Payarik districts. Of these, two western districts use water for other purposes as well, while the others simply use too much water [2].

Table 2. Index of agricultural land and water use efficiency in the cultivation of agricultural products in the region.

| № | Districts     | Land use efficiency index $I_{eu}$ | Water use efficiency index $I_{euw}$ |
|---|---------------|-----------------------------------|-------------------------------------|
| 1 | Bulung'ur     | 2.6                               | 1.3                                 |
| 2 | Jomboy        | 2.6                               | 0.8                                 |
| 3 | Ishtikhon     | 2.6                               | 1.1                                 |
| 4 | Kattakurgan   | 1.1                               | 0.7                                 |
| 5 | Narpay        | 2.4                               | 0.5                                 |
| 6 | Nurobod       | 0.1                               | 1.3                                 |
| 7 | Aqdaryo       | 3.4                               | 0.9                                 |
| 8 | Pastdargom    | 1.3                               | 0.6                                 |
| 9 | Pakhtachi     | 1.3                               | 0.6                                 |
| 10| Payariq       | 1.3                               | 0.7                                 |
| 11| Samarkand     | 4.9                               | 1.9                                 |
| 12| Tayloq        | 8.1                               | 2.3                                 |
| 13| Urgut         | 2.2                               | 1.8                                 |
| 14| Koshrabat     | 0.3                               | 14.0                                |
|   | By province   | 1.0                               | 1.0                                 |

Factors influencing the efficiency of land and water use include the provision of areas with fertile land and sufficient water supply. Determining the effectiveness of their joint use allows us to draw general conclusions. In particular, a separate study of the efficiency of agricultural production from land and water resources does not give clear, satisfactory results. Because the lack of land or water resources does not have a strong impact on the agriculture of the region. Therefore, it is necessary to determine the effectiveness of their joint use. This can be expressed by 2 indicators.

First indicator: Brutto coefficient $\left( I_{eu} + I_{euw} \right) / 2$.

The brutto coefficient of land and water use efficiency was determined by the arithmetic mean of the land and water indices (see table 3). In this regard, Koshrabat is far ahead, and as noted above, the low amount of water used by the district is the reason for this situation. Moreover, Taylak district has a much better performance (as in other eastern districts). It should be noted that the brutto efficiency
does not fully reflect the potential of the regions. This is because the efficiency of one of the land or water resources is so high that it can cause the other to overestimate or underestimate its potential.

Second indicator: Netto coefficient or efficiency \( \sqrt{1-\text{I_{eul}}} \).

The netto coefficient is determined by the average geometric index of these indices, which more accurately reflects the characteristics of the use of land and water resources of the regions (see figure 1). The reason for this is that the role of precipitation in agriculture, especially in livestock sector and dry farming, is also high. However, this indicator provides an opportunity to obtain sufficient information about the state of the regional economy, the agricultural sector, including the efficiency of land-water use. In the regions, different indicators are recorded relative to its average. In particular, Taylak and Samarkand districts have a significant advantage, recording 4 and 3 times higher than the main indicator, respectively (see table 3).

The efficiency of land and water use in these districts depends, firstly, on the convenience of natural conditions and, secondly, on the fact that fertile agriculture (intensive form of farming and livestock) has traditionally developed in the past. In addition, these areas are the main growing regions in terms of population and the region’s economy. Their main problem is that the rational use of land and water resources is not regulated. Examples include the transfer of agricultural land to other sectors, problems with water distribution and some shortcomings in the free operation of activities [3].

Table 3. Land and water use efficiency index.

| №  | Districts   | Brutto efficiency \( E_b \) | Netto efficiency \( E_n \) | Ratio |
| --- | ----------- | ---------------------------- | -------------------------- | ----- |
| 1  | Bulung'ur  | 2.0                          | 1.8                        | 1.1   |
| 2  | Jomboy     | 1.7                          | 1.4                        | 1.2   |
| 3  | Ishthikhon | 1.9                          | 1.7                        | 1.1   |
| 4  | Kattakurgan| 0.9                          | 0.9                        | 1.0   |
| 5  | Narpay     | 1.5                          | 1.1                        | 1.4   |
| 6  | Nurobod    | 0.7                          | 0.4                        | 1.8   |
| 7  | Aqdaryo    | 2.2                          | 1.7                        | 1.3   |
| 8  | Pastdargom | 1.0                          | 0.9                        | 1.1   |
| 9  | Pakhtachi  | 1.0                          | 0.9                        | 1.1   |
| 10 | Payariq    | 1.0                          | 1.0                        | 1.0   |
| 11 | Samarkand  | 3.4                          | 3.1                        | 1.1   |
| 12 | Tayloq     | 5.2                          | 4.3                        | 1.2   |
| 13 | Urgut      | 2.0                          | 2.0                        | 1.0   |
| 14 | Koshrabat  | 7.2                          | 2.0                        | 3.6   |
| 15 | By province| 1.0                          | 1.0                        | 1.0   |

The second group includes regions with different conditions and levels of development, the average efficiency of land and water resources which is 1.8 times higher than the regional average. Both intensive and extensive branches of agriculture are well organized in these regions. Extensive farming prevails only in Koshrabat district. The reason for this, as noted above, there are available conditions and large area for spring farming and livestock sector.

The real situation of the efficiency of land and water use in the region can be demonstrated by the third group. Because these are the main base areas of the region’s agricultural sector, they are better provided with land and water resources than others. However, the efficiency of using these resources
lags far behind their potential, although these districts have ample opportunities to develop the regional economy (besides Narpay and Pakhtachi).

**Figure 1.** Efficiency of netto use of land and water resources.

In terms of agricultural production and land and water use efficiency, Nurabad district lags far behind the regional average. The reason for this is, firstly, the unfavorable conditions of the region, and secondly, the unsatisfactory conditions and opportunities for the development of an intensive form of agriculture accordingly.

**Table 4.** The netto coefficient of efficient use of land and water resources in the districts of the region.

| №  | In relation to the indicator | The indices range | Districts | Average index |
|----|-------------------------------|-------------------|-----------|---------------|
| 1  | Very high                     | Above 3.0         | Taylak, Samarkand | 3.7           |
| 2  | High                          | 1.5 – 2.0         | Urgut, Koshrabat, Bulungur, Ishtikhon, Aqdaryo | 1.8           |
| 3  | Average                       | 0.9 – 1.4         | Jambay, Narpay, Payariq, Pastdargom, Kattakurgan, Pakhtachi | 1.0           |
| 4  | Very few                      | Less than 0.5     | Nurobod | 0.4           |
Differences in the use of land and water resources can be identified through the ratio of brutto and netto efficiencies.

\[
\frac{E_b}{E_n}
\]

As can be seen from the table, the biggest difference is in Koshrabat, half of which is observed in Nurabad districts. One-sidedness in the use of land and water resources in these areas is obvious. On the contrary, in Kattakurgan, Payariq and Urgut districts there is no difference in the use of land and water resources. These cases indicate that the regions have problems with the provision of land and water resources, their agricultural production potential.

3. Research results
In this study, for the first time, the specific (each separately) and integral (joint) efficiency (in brutto and netto coefficients) of land and water use was calculated.

When grouping the results of netto efficiency indicators, the highest rate was recorded in suburban areas (Taylak, Samarkand), and the lowest in the largest desert (Nurabad) district.

However, in the third group of districts, which are the backbone of the region's agricultural sector, the efficiency of land and water use is lower than expected. It is clear that the efficiency use of land and water resources does not depend only on the fact that they are well supplied.

This indicates that there are problems with the intensive organization of agriculture in these areas. The difference between brutto and netto coefficients was also determined. In this regard, the difference in land and water use was high in Koshrabat (3.6) and Nurabad (1.8) districts respectively.

Therefore, it is necessary to improve the extensive form of agriculture (pastoralism, dry farming) in these areas and in other areas, which are generally poorly supplied with land and water resources.

4. Conclusion and suggestions
There is a decrease in land and water resources per capita. If this process continues, in 2030 each person will have 8 hundredths of irrigated land and 32 liters of water, and by 2050 - 5 hundredths of land and 20 liters of water resources. However, in our (agro-industrial) conditions, a person needs at least 6 hundredths of irrigated land and 40 liters of fresh water a year to live a normal life. From the above figures, it can be seen that before 2050, the shortage of land and water resources in the region will begin.

However, given that these resources are not evenly distributed in all regions, it is not difficult to feel that in some disadvantaged areas, land and water resources are beginning to run out. To prevent this problem, we need to do the following:

- when planning the regional economy, it is necessary to take into account which (in agrarian conditions,) sectors it is most dependent on. Artificial production planning does not lead to good results;
- complex work on the use and protection of land and water resources (study, decision-making, implementation and outcome) should be carried out. Control plays an important role in this.

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