Water resource potential of agricultural lands of Omsk region

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Abstract. The basis for planning the activities of the agro-industrial complex and justifying their development in the future is the availability of natural resources. Water resources are an important component of the natural resource potential of the region, playing a key role in the development of an integrated agricultural economy. In determining the environmental sustainability of water bodies, the study of quantitative indicators of moisture resources and their spatial and temporal variability is of paramount importance. The correct presentation of resources and natural water reserves is the key to the successful development of economic sectors and the basis for the geo-ecological substantiation of the territory. A feature of the water resource potential of the Omsk region is the uneven distribution of atmospheric humidification over the territory, which, together with seasonal and long-term fluctuations, can serve as the basis for the manifestation of negative consequences of water. The paper analyzes the alternation of wet and dry years in the long-term period and their influence on the moisture content of the territory. Based on abbreviated summary curves, the duration of periods of continuous dry and wet years are shown, and the trend of long-term changes in the amount of precipitation in the study area.

1. Introduction
The presence of high natural resource potential of the territory is the main factor in the location of productive forces, making it possible to develop economic activities and create conditions for improving the population's well-being. On the other hand, it is obvious that the development of large industrial, economic, and agricultural complexes is accompanied by an increase in the impact on the surrounding area and an increase in the development of natural resources [1]. It is known that excessive use of natural resources can lead to a decrease in the environmental sustainability of the environment and, if specific critical values are exceeded, up to destruction.

The Omsk Region has good water resource potential. Despite the large reserves of water resources, the uneven distribution of surface and groundwater throughout the region creates specific difficulties in the water supply to consumers. A particularly alarming situation arises among water consumers located in the south of the region, who withdraw water directly from the Irtysh River. A decrease in the river level in dry years [2], with a decrease in precipitation and other water supply sources, can lead to catastrophic interruptions in the water supply to agricultural producers. In addition, there is a problem opposite to the shortage of water, which significantly increases in high-water years and is manifested by flooding and flooding of settlements and agricultural lands. Strengthening the processes...
of flooding is facilitated by human activities aimed at improving vital activity, which indirectly affects the change in the characteristics of surface and underground runoff formation. Thus, the problems associated with water resources in the Omsk region are relevant because of the great dynamism of both natural factors influencing the processes of humidification and the increasing anthropogenic load on aquatic and near-aquatic ecosystems.

The solution to the existing problems should be based on implementing a system of planned engineering and survey, research and construction, and operational activities at the level of performance of life-supporting functions of the population. The urgency of solving water resources problems in the Omsk region is due to a set of factors. On the one hand, the reason is the great dynamism of natural factors that influence humidification processes. On the other hand, the reason is the increasing anthropogenic load on aquatic and near-aquatic ecosystems.

The primary purpose of the work is to identify the possibility of creating conditions for rational use of natural resources in the Omsk region based on taking into account the natural resource potential of the region in compliance with the balance of available resources and their expenditure. As an object of research, the region's water resources are taken as the most important for the life of the population and a natural resource more susceptible to anthropogenic influence.

Comparison of the parameters of economic activity with the ecological (natural resource) potential of the environment is possible based on a detailed examination of the functioning of the geosystems of the studied region and a quantitative assessment of the parameters of the environment [3, 4]. As for the natural resource potential of water bodies, they are primarily formed due to climatic factors. The leading roles in which the general heat supply and the humidification regime belong.

2. Formulation of the problem

Water resources for the Omsk region represent a significant part of the natural resource potential. Water resources are the most important factors in the socio-economic development of territories that dictate the direction of economic activity. The availability of water resources and their qualitative state are the determining factors in developing and deploying industries and agriculture. In this regard, an important condition for the effective development of territories is the correct presentation of the quantitative and qualitative characteristics of the available water resources, the peculiarities of their formation and distribution over the territory and in time.

The location of the Omsk region in the continental climate zone with significant fluctuations in heat and power resources predetermined different conditions of water supply both across the territory and in different seasons of the year and over a long period. The provision of the study area with thermal and water resources has a common latitudinal-zonal variability. A decrease in heat resources from south to north affects the change in moisture content from arid, south of the territory (Russko-Polyansky district), to waterlogged – in the northern part of the region (Ust-Ishimsky district). It is obvious that such changes in water availability create prerequisites for the emergence of water problems associated with both shortages of water resources and the negative impact of water on the environment. It should be borne in mind that the water problems observed in the region are associated with the peculiarities of humidification, which change from year to year, and with the increasing anthropogenic load, both on water bodies and on the catchment area [5].

It is important to note that special attention should be paid to identifying the negative consequences of the population and the ecology of repeated low-water and high-water periods when studying issues related to water availability. In turn, the study of the regularities of the formation of the water-resource potential of the drainage basin, changes in quantitative characteristics depending on heat and power resources, their distribution over the territory of the region, taking into account geographic and local features, make it possible to identify the need and the possibility of designing reclamation measures to reduce the negative consequences of water and their optimal use in agricultural production.

The territory of the Omsk region is located in the southwest of Siberia, stretching from north to south for almost 600 km, between 53° and 58° northern latitude. The distance from the western border to the eastern border of the Omsk region in the widest part is more than 300 km, between 70° and 76°
east longitude, and is completely within the West Siberian Plain. The area of the Omsk region is 141.1 thousand km$^2$; it borders on the Tyumen, Tomsk, Novosibirsk regions, and the Republic of Kazakhstan. The region's territory is subdivided into 32 districts.

The geographical position of the study area determines the variety of natural resource potential [6]. Geographic zones change here from north to south following changes in climatic factors.

Orographically, the region's territory is located in the Middle Ob basin of the West Siberian Plain and is a combination of independent lowlands and uplands.

The structural features of the hydrographic network of this territory are primarily due to the structure of the relief and climatic characteristics. The flat surface and aridity of the southern part are characterized by an almost complete absence of the river network. The presence of many shallow areas in the central and northern parts with a simultaneous decrease in heat and energy resources of evaporation determines the presence of many lakes and swampy areas. The location of elevations along its periphery determined the main direction of runoff – from the marginal parts of the territory to the center. The territory is completely located in the basin of the river. Irtysh, which crosses the region from south to north. In hydrogeological terms, groundwater in the Omsk region is widespread. The waters in the Omsk region are located at different horizons and have different degrees of mineralization [7]. The resources most suitable for use are located in the Oligocene-Quaternary deposits of the first hydrogeological complex of the upper hydrogeological level. Compared to the southern regions, the northern regions of the Omsk region are better provided with underground resources. However, the groundwater level in agriculture is currently at a low level throughout the territory.

3. Materials and methods
In terms of water consumption, agricultural production significantly surpasses many sectors of the national economy. An important and most vulnerable area with the moisture supply of the agricultural complex is crop production, the productivity of which depends on the moisture content of the root layer. Due to the insufficient development of irrigation systems for artificial soil moistening, the only source of moisture supply for the root layer is the natural moisture content of the territory.

Precipitation is the main source of water resources in the territory. The amount and distribution of precipitation in the area under consideration are mainly determined by the characteristics of the atmosphere's general circulation, particularly by the frontal activity of western cyclones.

For a quantitative assessment of the temporal and spatial characteristics of the water resources' variability under consideration, an analysis of long-term series of annual amounts of atmospheric precipitation was implemented for various districts of the Omsk region. The annual data of the state statistical reporting for 1966-2018 were used as the initial information. Based on the average long-term values of atmospheric precipitation for the specified period, the calculation of modular coefficients was carried out, deviations from the norm were determined, and the ordinates of the shortened total curves were calculated.

Such calculations were performed for 27 meteorological stations in the Omsk region. Figure 1 shows graphs of the relative deviations of annual precipitation amounts from the average values for 1966-2018 and reduced summary curves of annual precipitation amounts for typical areas of the region, selected depending on latitudinal zonation.
Figure 1. Plots of the relative deviations of annual precipitation from the average for 1966-2018 (Row 1) and reduced summary curves (Row 2) of annual precipitation

4. Results and discussion
An analysis of the graphs of long-term data on the relative deviations of the annual amounts of atmospheric precipitation leads to the conclusion about the non-uniform duration and alternation of wet and dry periods of the years. In general, in the Omsk region, the average duration of wet years is slightly higher and amounts to 27 years. At the same time, the duration of dry years is 25 years. In terms of precipitation, the duration of continuous low-water and high-water does not remain the same throughout the territory. Also, we paid attention to the nature of the alternation of dry and wet years for the southern, central, and northern parts of the territory.
So, the duration of wet years in the northern part of the territory is on average 20 years, and the dry years is 25 years. For the central part, these indicators are in both cases, and for dry and wet periods are the same and amount to 25 years. According to weather station data, the duration of wet years reaches 28 years for the southern part of the territory, and the duration of dry years is less than about 25 years. This fact is obviously due to the peculiarities of the location and structure of the study area and the significant variation in the amount of atmospheric precipitation in the southern part compared to the northern regions.

Variation coefficients (Cv) were also calculated for the annual amounts of atmospheric precipitation for the long-term period from 1966 to 2018 at 27 meteorological stations in the Omsk region. Calculations showed an insignificant change in the Cv values of atmospheric precipitation from north to south from 0.2 to 0.23. The average long-term precipitation sums by meteorological stations for the period under study tend to increase from south to north with a simultaneous decrease in heat and power resources [8]. Table 1 contains the values of the warm-water resources of the study area according to the characteristic meteorological stations with latitudinal zoning.

### Table 1. Average long-term annual values of the water equivalent of heat and power (FER) climate and atmospheric precipitation by typical meteorological stations of the Omsk region

| Meteorological station | Latitude of the meteorological station location, northern latitude degrees | Water equivalent of FER of the climate Zx, mm | Atmospheric precipitation, mm |
|------------------------|-------------------------------------------------|---------------------------------|-----------------------------|
| Russian glade          | 53.78                                           | 1310                            | 363                         |
| Omsk                   | 55.00                                           | 1285                            | 411                         |
| Tara                   | 56.90                                           | 1210                            | 452                         |

5. Conclusion
The growing demand for products of the agro-industrial complex dictates an increase in the need for agricultural production in water resources. In the absence of artificial irrigation systems, the most optimal conditions for developing agricultural sectors have territories with sufficient conditions of natural moisture. In turn, the moisture content of the territory depends not only on the amount of precipitation but also on the degree of provision with thermal resources. The ratio of changes in thermal and water characteristics in the south and the northern part of the Omsk region (Russkaya Polyana and Tara) is about 20% in terms of precipitation and about 8% in terms of heat resources.

Analysis of the long-term series of changes in the annual amounts of atmospheric precipitation, according to the data of meteorological stations of the Omsk region, indicates the presence of an upward trend, starting from 2000, which is observed throughout the region and continues to grow.

Achievement of rational conditions for water use in the agricultural development of territories is possible only under the condition of a joint analysis of the current state of the water resource potential of the territory of the Omsk region. Rational water use should consider climatic fluctuations and anthropogenic influence on changes in the characteristics of runoff formation.

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