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ROLE OF THERMAL RESOURCES OF OMSK REGION IN THE AGRICULTURAL INDUSTRY DEVELOPMENT

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Abstract

The successful and safe development of economic activities that create conditions for compliance with the rational nature management principles involves maintaining a balance between the economic potential of society and the ecological potential of the environment. The natural resources are the basis for the development of production forces and rational environmental management. To ensure safety of natural ecosystems, it is necessary to pay attention to the characteristics of the the natural resource potential of the territory, which determines the production and economic orientation of the territory. The territorial distribution of production forces depends on the type of economic activity ensuring its stable economic development. Omsk region occupying a vast territory from south to north is characterized by a variety of natural and climatic features. A significant difference in heat and moisture supply predetermines a difference in the economic development of the r territory. The study of zonal distribution of energy resources and their temporal variability has always been crucial. The current study assesses thermal resources of Omsk region: values of the components of the heat energy balance are determined, patterns of their territorial distribution are revealed, and types of dependences are identified. The data obtained are of great importance in assessing the interaction of the environment and anthropogenic activities. Quantitative indicators of heat and power resources and moisture supply can be used in the long-term planning of economically effective economic activities and to increase the capacity of production forces of the agro-industrial complex.

Keywords: Heat supply, economic potential, natural resource potential, production and economic potential

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1. Introduction

Economic activities depend on the resources of heat and moisture supply. The rational and efficient management of available natural resources requires a study of these factors.

Omsk region has sufficient natural resource potential, which creates the basis for the development of economic activities and the general economic development of the region. One of the important areas of development of the natural resources is the development of the production and economic sector in accordance with the territorial combination of natural resources.

2. Problem Statement

Among the main factors of the environment, which determine the effective distribution of productive forces and affect the efficiency of the agro-industrial complex, is the heat and moisture supply. One of the priority areas of economic development is the study of heat and power and water balance features and their temporal variability, which form the basis of the environment-forming factors of the ecosystem.

Among the components that assess the climate, the leading role belongs to solar radiation, as it is the basis of all climatic processes (Stauning, 2011), and an integral component that affects the formation of thermal energy resources. It is heat resources that determine the economic efficiency of agricultural activities (Allen et al., 1998).

Thus, the study of heat and power resources and the reliable assessment of the income and expenditure components are national economic tasks for the development of the territory and the most efficient use of natural resources.

3. Research Questions

One of the indicators of heat supply is the radiation balance, which characterizes the dynamics of the movement of radiant energy absorbed and emitted by the surface, and the return of the oncoming radiation. The radiation balance of the earth surface R is the difference between the absorbed flux of short-wave radiation Rk and effective radiation E, R = Rk - E. Short-wave radiation Rk is the energy of the Sun, which arrives at the earth surface in the form of straight line S and scattered D radiation and depends on the albedo (coefficient reflections) of the surface Rк = (S + D) (1 -A), where A is the albedo.

Total radiation Q is an indicator of the sum of direct S and scattered D radiation, as the main incoming component of the radiation balance is distributed over the territory depending on the latitude of the area and the cloudiness (Grigoryev & Budyko, 1965). When analyzing the annual values of the total radiation, its latitudinal zoning is well traced in the direction of an increase in its values from north to the south. The absorbed radiation depends on the total radiation and reflectivity of the surface (albedo).

The maximum values of effective radiation are observed in winter. This is due to the fact that the soil freezes to the greatest depth and the heat reserves are minimal. In addition, the snow cover prevents the penetration of heat from the soil into the air. Omsk Region on the West Siberian Plain is located at an equal distance both from the Atlantic Ocean and the continental center of the Asian continent. Under the influence of these two weather centers, its climate is continental. The flatness of the territory and openness

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from the north and south contributes to the invasion of dry and hot air masses from the South Kazakhstan and Central Asian deserts in summer and the flow of cold air from the Arctic seas in winter. In any season, sharp changes in the weather are possible. In the cold season, a significant part of the territory is under the predominant influence of the western spur of the Siberian maximum, which causes stable frosty weather. The strongest cold snaps are due to northeastern invasions.

4. Purpose of the Study

The present study aims to assess the heat and power resources of Omsk region. In accordance with the goal, the study solves the following tasks:

1. to conduct a comprehensive analysis of the conditions under which the heat and power balance components are formed and distributed.

2. using the parameters of the water equivalent, to conduct a quantitative assessment of the values of heat and power resources, which are the main characteristic when locating industrial facilities and determining the main direction of the agro-industrial complex in Omsk region.

5. Research Methods

Based on the data from 24 meteorological stations located in Omsk Region, the main characteristics of the radiation balance were determined. The analysis showed that in the warm season, the radiation balance is positive with the highest values in June-July and reaches the lowest values in December-January.

The period with a positive radiation balance is six to seven months in the north, and seven to eight months in the south. During the transitional seasons, the radiation balance in the northern and southern parts is significantly different; in the summer and winter months, it is the same.

An important feature of the Omsk climate is the abundance of solar radiation due to the low level of cloudiness and long summer days. The average duration of sunshine per year is 2223 hours; there are 57 days without the sun.

The total average inflow of direct solar radiation onto the horizontal surface is 4567 MJ/m2, scattered radiation - 1324 MJ/m2. The presence of dust and smoke and cloudiness can affect the total amount of incoming direct solar radiation in the direction of decreasing it by up to 47%. At the same time, the amount of received scattered solar radiation increases 1.5 times. As a result, the total inflow of total radiation is 4138 MJ/m2. From November to January, the share of direct radiation is 27 ... 32%, and in summer it increases to 54 ... 58%.

The amount of reflected radiation depends on the reflectivity (albedo) of the body. In summer, 15 ... 20% of the radiation is reflected. In winter, when the earth surface is covered with snow, the reflectivity (albedo) is 60 ... 70%, the albedo of freshly fallen snow increases to 80-90%. On average, the active earth surface reflects 26% of the incoming short-wave radiation.

As a result, the radiation balance has a positive value, and is equal to 1590 MJ / m2, which is 30% of the annual amount of total radiation.

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The inflow of total solar radiation, which determines the thermal regime in the north of the region, is 4000 MJ / m2 per year with the highest value in June - 590 MJ / m2 per month. In the southern regions, these values are 4200 and 670 MJ / m2, respectively.

6. Findings

Based on the previous studies (Belonenko et al., 2012), an estimate of the heat resources of the earth surface i.e. the energy base of all processes occurring in the ecosystem, should be determined by the values of thermal energy resources *Tк* or the water equivalent of the value *Zк*. Due to the poor thermal balance study of the territory of Western Siberia, the value of the water equivalent of heat and energy resources was determined by indirect methods based on the relationship of this value with standard meteorological values measured at meteorological stations. The values of Zк are shown in Figure 01.

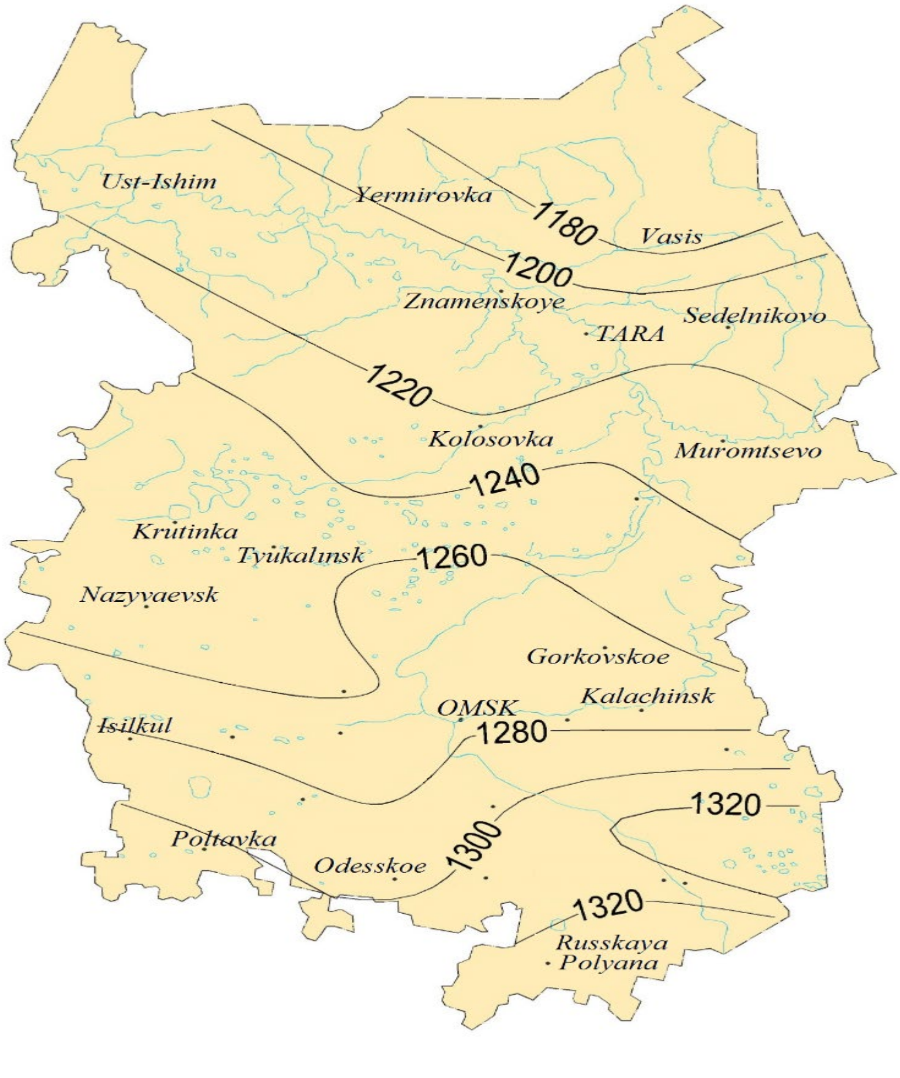

Figure 1. Water equivalent of thermal energy resources of the climate *Zк*, mm per year

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Figure 01 shows that the latitudinal zoning of distribution of the water equivalent of heat energy resources of the climate *Zc* is observed with a decrease in the values from north to south. Table 1 shows data on the intra-annual thermal energy resources of the climate for three meteorological stations located in the northern, central and southern parts of Omsk region.

The position of Omsk region is such that every spring part of this energy (18-20% of the annual amount) is spent on compensating for the winter effects of cold, i.e. for heating and melting snow and ice. Therefore, the energy resources for creating the biological mass are 18-20% less than the thermal energy resources of the climate (Tusupbekov et al., 2021).

Table 1. Shortwave component of FER of the climate in an average year, MJ / m^2

Meteo station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Per year
Tara	4	10	35	220	330	355	360	280	160	65	7	0	1819
Omsk	4	17	71	277	369	390	373	302	189	75	8	0	2075
Poltavka	10	18	72	298	380	400	380	320	190	80	16	6	2166

During the spring-summer season, the amount of heat in the soil-ground layer increases by 100 MJ / m^2 while during the autumn-winter season it decreases by the same amount. In the north, 1000-1200 MJ / m^2 of heat are spent on the evaporation of moisture from the soil, and 150-300 MJ / m^2 - on heating the air and daily heat turnover (night radiation). In the south, 850 MJ / m^2 are spent on moisture evaporation, and the same amount is spent on heating the air and soil (daytime accumulation of energy in the soil and nighttime cooling, i.e. heat outflow per night into the atmosphere). Table 2 shows the values of TER of evaporation and phytomass creation for the warm months. The inflow of energy in winter is 100-120 MJ / m^2, i.e. about 5% of the annual amount.

Table 2. Total evaporation heat energy resources, MJ / m^2

Meteo station	IV	V	VI	VII	VIII	IX	X	Per year
Tara	40	300	319	332	262	157	60	1470
Omsk	136	342	360	347	296	188	70	1739
Poltavka	140	352	369	357	316	190	70	1794

Thermal energy resources (TER) of evaporation Tz in cold countries are always less than Tc. The TER of evaporation characterizes the upper limit of heat consumption for evaporation. The water equivalent of the Tz value is the maximum possible evaporation, the indicator of the highest evaporation value, with the complete consumption of Tz for the evaporation processes. In nature, the actual evaporation Z can never reach its theoretical maximum Zm, since part of the energy is inevitably spent on heating water and transporting steam from the evaporating surface (Mezentsev & Karnatsevich, 1969). Figure 02 shows the annual water equivalent rate of evaporation TER.

The solar energy regime determines the temperature regime of the territory. Severe, long winters, relatively short but hot summers, short transitional seasons, late spring and early autumn frosts, sharp temperature fluctuations are the features of the local climate. Omsk region has rich natural resources and good prospects for developing existing resources.

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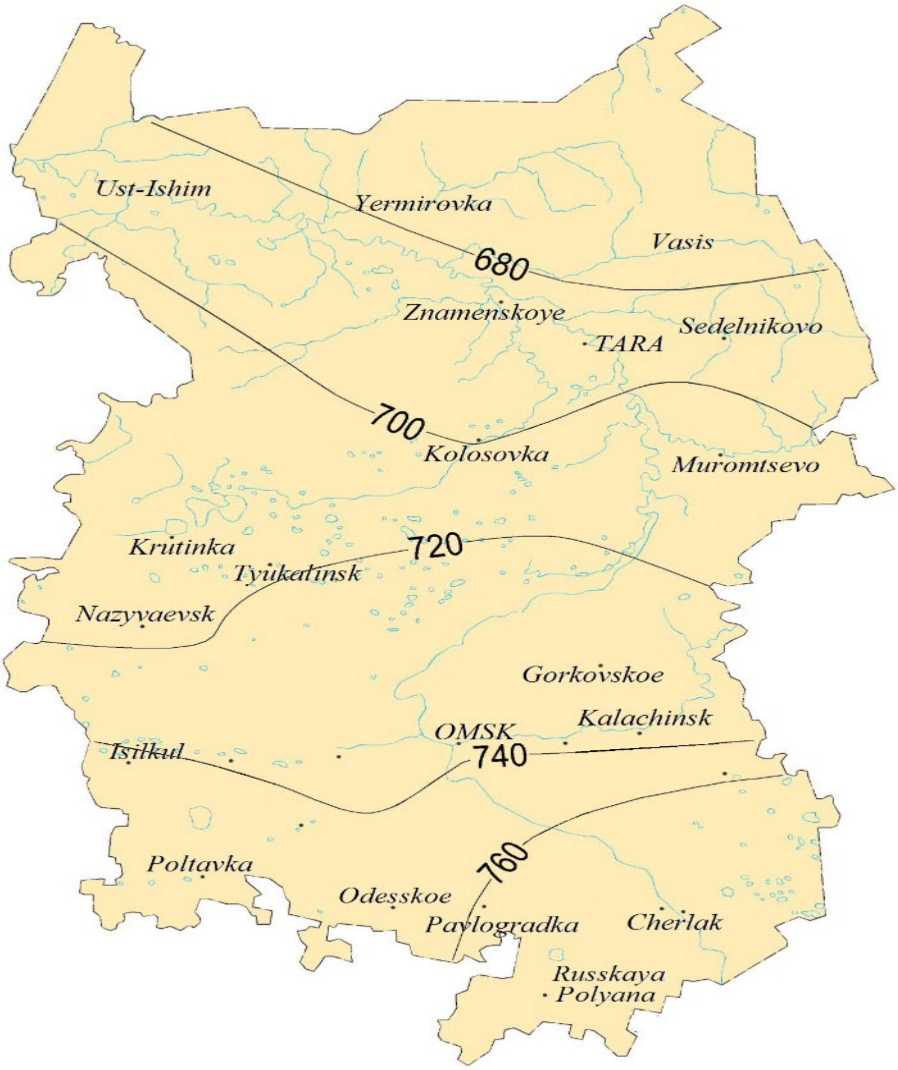

Figure 2. The average annual water equivalent of thermal energy resources of the climate of total evaporation *Zm*, mm

7. Conclusion

The factors affecting the formation and spatial distribution of natural resources is thermal and water resources, their intra-annual distribution and long-term variability. The volume of these resources and their spatial distribution depend on the input and output elements of heat and power and water balances.

The spatio-temporal distribution of heat and moisture elements results in the formation, development and predominance of certain types of soil and vegetation cover, which differ in their inherent structure of incoming and outgoing elements of moisture and heat turnover, productivity of phytocenoses, phytomass reserves, ecological capacity, ecological technological intensity and maximum permissible technogenic load.

The results of the study of heat and power and water balance characteristics presented make it possible to use the territory for various economic activities, to develop priority areas of the agricultural industry and identify natural resources which are the basis for the economic development of Omsk region.

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