



Comparison of AHP and TOPSIS Methods in Zoning Lands Suitable For Rainfed Wheat Cultivation in the Balekhlo-Chai Basin of Ardabil

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Abstract

Background and Objective: Wheat, as one of the strategic agricultural products and staple grains in the global food basket, plays a key role in ensuring food security and livelihoods of human societies. According to the report of the Food and Agriculture Organization of the United Nations (FAO), wheat is the third most important cereal crop in terms of production in the world after corn and rice, which plays a fundamental role in providing calories and protein needed by humans. Considering the strategic importance of wheat and the increasing need to increase its production, locating and optimally allocating suitable lands for cultivating this crop is considered one of the main priorities in the agricultural sector. The aim of this study is to compare the AHP and TOPSIS methods in order to zone lands suitable for rainfed wheat cultivation in the Balekhlo-Chai watershed of Ardabil.

Methodology: In this study, precipitation, temperature, altitude, slope and soil depth data of the Balekhlo-Chai watershed of Ardabil were used. Then, by processing the data in a GIS environment, a map of information layers was prepared for each of the criteria. The AHP method was used to determine the weight of the criteria and the TOPSIS model was used to prioritize the options. Then, by overlapping and combining the studied criteria, the final map of areas susceptible to rainfed wheat cultivation was determined.

Findings and Results: The results of data analysis using the AHP method showed that about 37 percent of the land in the Balekhlo-Chai watershed is very suitable for rainfed wheat cultivation, 22 percent suitable, 24 percent slightly suitable, and 17 percent unsuitable. Also, based on the TOPSIS method, about 37 percent of the area of the Balekhlo-Chai watershed is suitable, 32 percent slightly suitable, and 31 percent unsuitable for rainfed wheat cultivation. The results of the AHP method indicate that the slope criterion with a weight of 0.220, the height with a weight of 0.144, the annual precipitation with a weight of 0.122, and the precipitation during the ripening and grain-setting stages with a weight of 0.106 are the most important criteria in the stages of wheat cultivation in the Balekhlo-Chai watershed. Also, the results of the TOPSIS model prioritization showed that Nir station is the closest option to the positive ideal, followed by Sarein and Ardabil, respectively.

Keywords: Agroclimate, AHP, Balekhlo-Chai, Rainfed Wheat, TOPSIS, Zoning.

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Extended Abstract

Introduction:

Understanding the climatic potential and climatic needs of plants is one of the important factors in increasing the efficiency and productivity of agricultural production. Awareness of climatic parameters and their effects on plant growth and yield plays a significant role in increasing agricultural production. Awareness of climatic parameters in rainfed agricultural practices is of particular importance. Given the high share of rainfed wheat cultivation in Iran, awareness of the characteristics of temperature and precipitation in different geographical areas, which are two factors affecting rainfed cultivation, is very important. Wheat, as a strategic crop and the most important crop, plays a significant role in ensuring food security in any country. Accurately understanding the ecophysiological needs of wheat and identifying environmental factors and climatic characteristics of areas susceptible to rainfed wheat cultivation can be of great help in identifying environmental limitations and capacities for the production of this important crop. The cultivation of rainfed crops in areas that lack suitable conditions for this type of cultivation has caused crises for rural communities and the environment in recent years. The only way to prevent this trend from continuing is to accurately identify areas suitable for rainfed crops.

Methodology:

In this paper, AHP and TOPSIS methods are compared in zoning of lands suitable for rainfed wheat cultivation in the Balkhlocha basin of Ardabil. The data used in this paper include climate data (annual temperature, rainfall (annual rainfall, germination rainfall, tillering rainfall, winter rainfall, flowering rainfall, grain yield rainfall) and land data including topography (elevation, slope) and soil (soil depth). Despite the limited number of stations, spatial interpolation was used to convert point data to surface and complete coverage of the basin. This work was done in order to estimate climatic values (such as rainfall) in areas without stations. The IDW method was selected as the most appropriate model in this study, then the results were classified and evaluated. In this study, a combination of AHP and TOPSIS models was used in ArcGIS software to integrate and analyze information layers.

Results and Discussion:

The results showed that 32.69 percent of the area of the study area has a very suitable slope (0 to 5 percent), 24.46 percent of the area of the study area has a suitable slope, and about 28 percent of the area of the study area has a slope of more than 13 percent, which is considered an unsuitable area for wheat cultivation in terms of describing the ability. Among the various criteria, slope has the highest weight and importance. After that, in descending order of importance, the criteria of altitude, annual rainfall, seeding rainfall, and flowering rainfall are located. Temperature is ranked sixth in terms of importance, and finally, the soil criterion has the lowest weight in this assessment. The results of data analysis using the AHP method showed that about 37 percent of the land is very suitable for rainfed wheat cultivation in the Balkhlocha watershed, 22 percent is suitable, 24 percent is slightly suitable, and 17 percent is unsuitable. Also, based on the TOPSIS method, about 37 percent of the area of the Balkhlochai basin is suitable, 32 percent is slightly suitable, and 31 percent is unsuitable for rainfed wheat cultivation. The results of the AHP method indicate that the slope criterion with a weight of 0.220, the height with a weight of 0.144, the annual rainfall with a weight of 0.122, and the rainfall during the ripening and graining stages with a weight of 0.106 are the most important criteria in the stages of wheat cultivation in the Balkhlochai basin. Also, the results of the

TOPSIS model prioritization showed that the Nir station is the closest option to the positive ideal, followed by Sarein and Ardabil, respectively.

Conclusion:

The results showed that a significant part of the Balkhlochay basin has good potential for the development of dryland wheat cultivation. The results of the TOPSIS model prioritization showed that the Nir station is the closest option to the positive ideal, followed by Sarein and Ardabil, respectively. According to the model results, Nir has more favorable climatic and land parameters for the development of dryland wheat cultivation compared to other stations, making it a close-to-ideal option. In general, for the development of dryland wheat cultivation, the Nir station obtained the highest score among the stations studied in the TOPSIS model because it is most similar to the ideal area for dryland wheat cultivation and is further away from unfavorable conditions.

Declarations

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- Conflict of Interest:** The authors declare no conflict of interest.
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