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Evaluation of Tourist-recreational Resources in the Background of Climate Change in Georgia

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Abstract

Environmental protection and the sustainable use of natural resources represent some of the most pressing challenges of the modern era. Effective decision-making in both ecological and economic contexts is increasingly dependent on an accurate understanding of environmental conditions. Key drivers of environmental degradation include the decline of biosphere components and biodiversity, climate change, and the intensification of damages caused by natural disasters. Recognizing these challenges, the World Meteorological Organization (WMO) and the World Tourism Organization (WTO) have emphasized the need to integrate climate change considerations into the evaluation of tourism and recreational resources. As a full member of both organizations since the 1990s, Georgia is required to assess its tourism potential in light of changing climatic conditions. This study examines the impacts of climate and climate change on the development of the tourism sector in Georgia, with a particular focus on mountain and ski tourism. For the first time, several Tourism Climatic Indexes were applied to evaluate recreational resources by integrating diverse meteorological parameters. The findings highlight the importance of incorporating climatic variability into tourism planning and tour design across different climatic zones, particularly in relation to the risks posed by negative climatic events. Furthermore, long-term changes in snow cover duration were analyzed across multiple mountain and ski resorts by comparing two time periods (1961–1985 and 1986–2015). The results underscore the critical need for climate-informed strategies to ensure the sustainable development of Georgia's tourism sector under changing environmental conditions.

Keywords: Climate change, Tourism Climatic Index, Glacier recession, World Tourism Organization (WTO), Natural resources, Tourism industry

Introduction

The dynamism and sustainability of the tourism industry are inherently linked to the geographical location, topography, vegetation, weather, and climate of a region (Becken, 2017). Among these factors, weather and climate are particularly significant, as they constitute the primary determinants of a region's bioclimatic resources, which are essential for the planning, organization, and development of the resort and tourism sector (Mieczkowski, 1985; Scott et al., 2012). Climate exerts both direct and indirect influences on tourism, shaping the attractiveness of destinations and affecting tourist flows and activity patterns (Amelung et al., 2007).

Adverse climatic conditions and climate variability can significantly alter tourism demand, influencing seasonal patterns and the distribution of visitor flows (Hall & Higham, 2005). Such changes have cascading effects on related sectors, making the understanding of tourism seasonality crucial for sustainable destination management. Investigating the seasonality of tourism enables researchers and planners to quantify the influence of natural-climatic conditions on tourism product formation, identify

key drivers of seasonal variation, and develop targeted strategies to mitigate seasonal inequalities (Peeters, 2017). Thus, the study of bioclimatic resources and climate-induced seasonality represents a fundamental aspect of modern tourism research, particularly in the context of climate change and evolving tourist preferences.

Methods and Materials

Climatic indices have long been employed to assess the suitability of tourism and recreational resources. To date, over 200 climate indices have been developed. Broadly, tourism climate indices can be classified into three main categories. Among these, elementary indices synthesize values from several meteorological parameters; however, they generally lack biometeorological information, which limits their applicability for evaluating tourism and recreational resources comprehensively.

To evaluate tourism-recreational resources in Georgia for the first time, the Tourism Climatic Index (TCI) (Kartvelishvili et al., 2023) was applied. The TCI integrates multiple meteorological parameters, including air temperature, atmospheric precipitation, relative humidity, and the average duration of sunshine, thus providing a composite measure of climatic suitability for tourism. The TCI enables the identification of tourism resource potential across different seasons and months and allows for the calculation of annual values. Nevertheless, the TCI does not fully incorporate the thermophysiological component essential for a comprehensive assessment of tourism comfort and demand.

To address these limitations and to better examine the impacts of climate change on tourism development, the Holiday Climate Index (HCI) was adopted in this study. The HCI is a more complex climatic index that incorporates a broader range of meteorological variables. Its development specifically addresses the deficiencies identified in the TCI, taking into account that different destinations require tailored climate information for diverse tourism segments, notably urban and mass tourism.

The HCI incorporates five key climatic variables: maximum air temperature (T_max, °C), relative humidity (RH), cloud cover (A), precipitation (R_d, mm), and wind speed (W, m/s). The combination of air temperature and relative humidity is expressed as the effective air temperature (T), calculated using a specialized nomogram (Japaridze & Khazaradze, 2019). The HCI is defined as:

$$HCI=4\times T+2\times A+3\times Rd+W \qquad (1)$$

Unlike most other climate indices, HCI values are expressed in points, allowing for a standardized evaluation of climatic conditions for tourism (Table 1). This framework enables a more nuanced assessment of tourism climates, providing a robust basis for both seasonal and annual planning in the tourism sector.

Table 1. HCI Categories and Rating

HCI Score	Rating	Category
90 – 100	1	Ideal
80 – 89	2	Excellent
70 – 79	3	Very good
60 – 69	4	Good
50 – 59	5	Acceptable
40 – 49	6	Marginal
30 – 39	7	Very unfavorable
20 – 29	8	Extremely unfavorable
10 – 19	9	Impossible
- 30 – 9	10	Impossible

Results

Georgia's unique geographical location, complex and highly dissected relief, diverse land cover, and specific climatic conditions result in the presence of nearly every type of climatic zone within its territory. This diversity makes Georgia particularly suitable for assessing the spatial and temporal distribution of tourism climates. Accordingly, the Holiday Climate Index (HCI) was analyzed across various locations in Georgia to determine its monthly distribution patterns (Fig. 1).

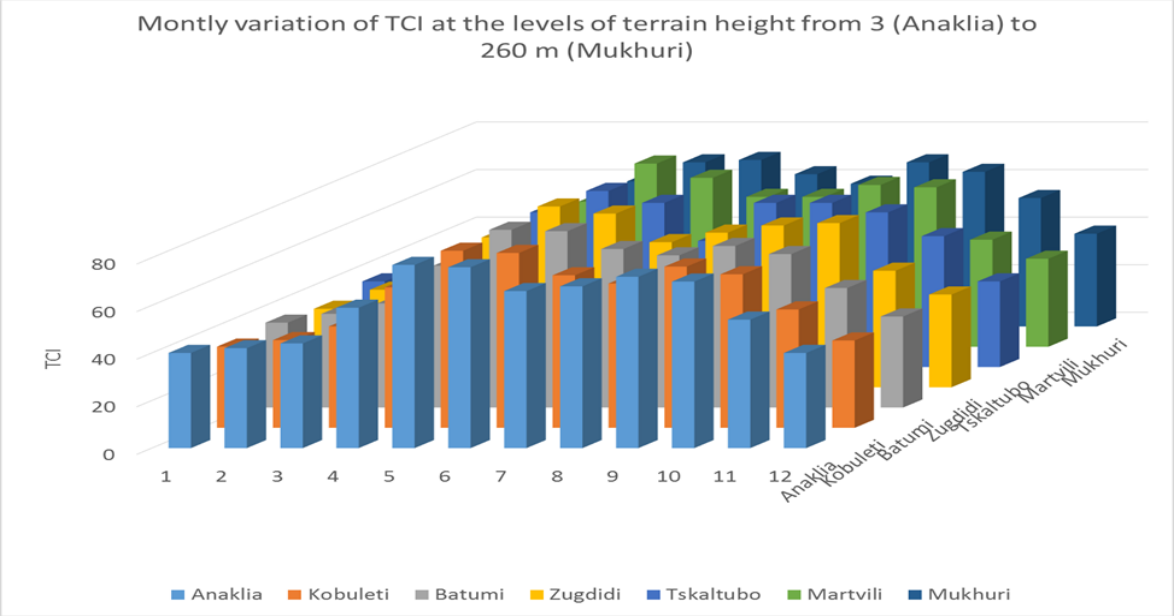

Figure 1. The distribution of the Holiday Climatic Index of rest according to the months

In Mestia, monthly HCI values recorded between 1956 and 2015 ranged from 34 (classified as "Unfavourable" in January) to 95 (classified as "Ideal" in September–October). The average monthly values over the entire observation period varied from 56.2 ("Pleasant" category in January) to 83.5 ("Excellent" category in August).

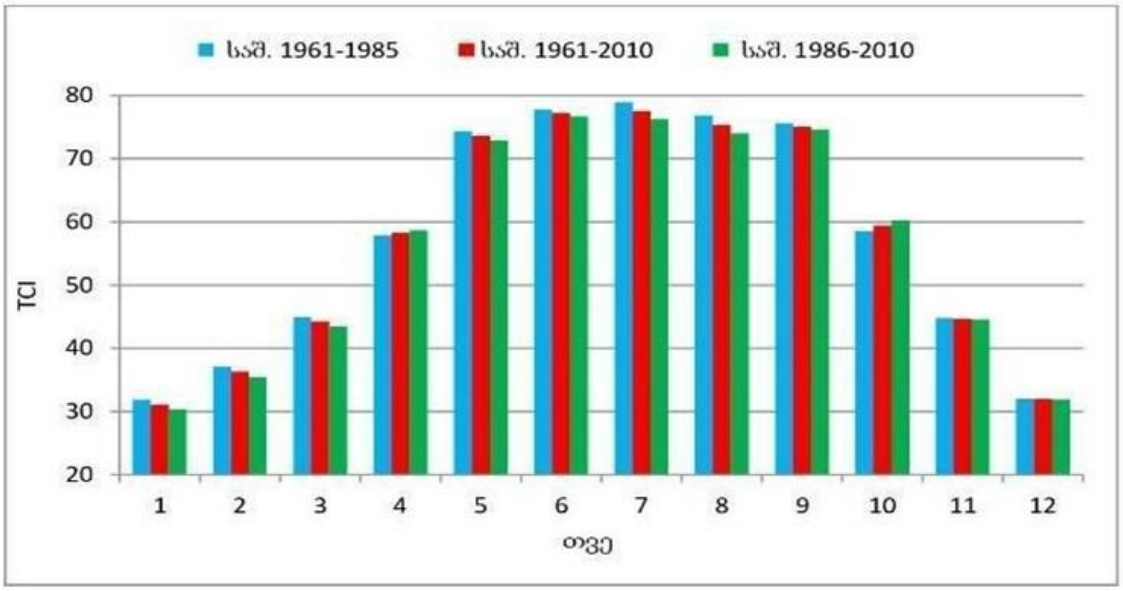

Figure 2. Average monthly values of HCI over the three observation periods

Analysis of the long-term trend in average monthly HCI values for Mestia revealed an overall negative tendency (Fig. 2). Specifically, a significant linear decrease in HCI values was observed for January, July, August, and December, as well as during both the cold and warm seasons of the year. These trends

suggest a gradual deterioration of bioclimatic conditions favourable for tourism in certain periods, which may have implications for the seasonal planning of tourism activities in the region.

To address the limitations of the Tourism Climatic Index (TCI), the Holiday Climate Index (HCI) was developed. According to its authors, the HCI provides a more representative assessment of the climatic suitability of a given area for tourism activities. The term "holiday" was purposefully chosen to reflect the index's specific focus on leisure tourism, distinguishing it from the broader concept of tourism, which is defined as: "a social, cultural, and economic phenomenon involving the movement of people between countries and places outside their normal environment for personal or business/professional purposes" (Amiranashvili et al., 2022).

A notable advancement of the HCI lies in its well-defined rating scale variables and the component weighting system. These features allow for a more nuanced and accurate evaluation of climatic conditions, thereby improving the capacity to assess tourism potential across different destinations and time periods.

Conclusion

The analysis indicates that the projected climate change in Georgia is unlikely to exert a significant impact on its tourism bioclimatic resources. Accordingly, it can be concluded that the bioclimatic conditions in Georgia have remained relatively stable, with only minor changes in the Holiday Climate Index (HCI), corresponding to a one-step variation in category, either upward or downward.

To enhance the resort and tourism potential of the country, it is essential to conduct a more focused and differentiated assessment of bioclimatic conditions. Such an approach would involve detailed studies of the bioclimatic resources of specific territories, enabling their optimal utilization for different types of tourism and diverse target groups.

Improving the quality and attractiveness of the resort and tourism industry requires systematic research aimed at understanding the spatial distribution of bioclimatic resources. This will support informed planning and development strategies, thereby maximizing the potential of Georgia's natural resources for sustainable tourism growth.

Competing interests

The authors declare that they have no competing interests.

Authors' contribution

All authors provided critical feedback and helped shape the research, analysis and manuscript.

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